HANDBOOK OF CANADA

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HANDBOOK OF CANADA

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PREFACE

THIS volume has been compiled with the object of presenting to visitors from Great Britain and elsewhere a brief outline of those institutions, industries, and sciences which are distinctly Canadian, or which have attained a position of relative importance in this country. All phases of Canadian life and effort can not be considered in a volume so limited, nor can any aspect of a subject so large be treated in detail.

The book contains no article on the history of Canada, but, whenever possible, the various subjects are presented historically in order to trace development as well as to indicate present conditions. All the articles are brief, and are intended for the general reader rather than for the expert in the subject treated. For those desiring detailed information a bibliography of different subjects is inserted at the back of the volume.

The inadequacy of the volume is fully realised but it is hoped that it may, at least, draw attention to some of the outstanding features of Canadian life and achievement.

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BIRTH AND GROWTH OF CANADA

Sir John Willison

In the half century of confederation there have been material changes in the temper and outlook of Canada. With a steady growth in national feeling there has been, also, a continuous assertion of political independence and constitutional autonomy; but in degree, as the Dominion's powers of self-government have been enlarged, it has established a closer co-operative relation with Great Britain and settled itself more firmly in the Imperial system.

The first conference to consider the project of union was held in 1864 at Charlottetown, in Prince Edward Island; but for many years before the meeting at Charlottetown, public men in the Canadas and in the eastern provinces had visions of confederation. Among the early advocates of union were Chief Justice Sewell of Quebec, and Bishop Strachan and John Beverley Robinson of Upper Canada, William Lyon Mackenzie, leader of the Upper Canada Rebellion of 1837, whose grandson now leads the Liberal party and holds the office of Prime Minister, P. S. Hamilton of Halifax, and J. C. Taché of Quebec, Alexander Morris of Ontario, whose "Nova Britannia" is among the interesting documents of Canadian history, and Sir Alexander Galt, the first High Commissioner for Canada in London. In 1854, the Hon. Joseph Howe and the Hon. J. W. Johnston, leaders of the rival parties in the Nova Scotia Legislature, were common advocates of union. Judge Haliburton, the father of American humour, once said: "England has three things to choose for her North American colonies: (1) Incorporation with herself and representation in Parliament, (2) Independence, and (3) Annexation with the States." But no doubt when the actual, practical issue appeared, the most powerful and effective of its eastern advocates was Sir Charles Tupper, as he was, perhaps, the foremost constructive statesman of his generation. For a century the Atlantic provinces have bred statesmen of sonorous eloquence, of high political genius, and of genuine devotion to Imperial ideals. Likewise these maritime communities, sharing the inspiration of New England, have been in a peculiar degree the nursery of literature in Canada.

The conference at Charlottetown arose out of a resolution introduced by Dr. Charles Tupper, Provincial Secretary, and adopted by the Parliament of Nova Scotia, on April 15th, 1861. It was in these words:

> Whereas the subject of a union of the North American provinces, or of the maritime provinces of British America, has been from time to time mooted and discussed in all the colonies; And whereas, while many advantages may be secured by such a union, either of all these provinces or of a portion of them, many and serious obstacles are presented which can only be overcome by mutual consultation of the leading men of the colonies, and by free communication with the Imperial Government: therefore resolved: That His Excellency the Lieutenant-Governor be respectfully requested to put himself in communication with His Grace the Colonial Secretary and His Excellency the Governor-General and the Lieutenant-Governors of the other North American provinces, in order to ascertain the policy of Her Majesty's Government and the opinions of the other colonies, with a view to an enlightened consideration of a question involving the highest interest, and upon which the public mind in all the provinces ought to be set at rest.

This resolution was forwarded to the Colonial Office and was transmitted by the Duke of Newcastle in a despatch of July 6th, 1862, to the Governor-General and the Lieutenant-Governors of the various provinces. In a separate despatch to the Lieutenant-Governor of Nova Scotia the Duke expressed unqualified approval of the objects of the resolution, but intimated that the British Government was not prepared to announce any definite policy on a proposal which seemed to originate with only one province. He said: "If a union, either partial or complete, should hereafter be proposed with the concurrence of all the provinces to be united, I am sure that the matter would be weighed in this country by the public, by Parliament, and by Her Majesty's Government, with no other feeling than an anxiety to discern and to promote any course which might be the most conducive to the prosperity, the strength, and the harmony of all the British communities in North America."

In 1864 the legislatures of Nova Scotia, New Brunswick, and Prince Edward Island discussed the narrower issue of a legislative union of the maritime provinces, and appointed delegates to a conference at Charlottetown, although there was disapproval, and particularly in Prince Edward Island, of a legislative union. While these proposals were under consideration in the east, the political leaders of Upper and Lower Canada had united to break the deadlock between the two provinces which sectional, racial, and religious differences had developed. It was recognised that the natural and desirable solution was a union of all the provinces under a general government. The Canadian Government, therefore, asked permission to send delegates to the maritime conference, and accordingly, on September 1st, 1864, delegates from all the provinces met at Charlottetown. The two Canadas were represented by Hon. John A. Macdonald, Hon. George Brown, Hon. A. T. Galt, Hon. George E. Cartier, Hon. Hector L. Langevin, Hon. Alexander Campbell, Hon. William McDougall, and Hon. Thomas D'Arcy McGee. The delegates from the Atlantic provinces were Hon. Charles Tupper, Hon. William A. Henry, Hon.

Jonathan McCully, Hon. Robert B. Dickey, and Hon. Adams G. Archibald for Nova Scotia; Hon. Samuel L. Tilley, Hon. W. H. Steeves, Hon. J. M. Johnson, Hon. Peter Mitchell, Hon. E. B. Chandler, Hon. John H. Gray, and Hon. Charles Fisher for New Brunswick; Hon. J. H. Gray, Hon. E. Palmer, Hon. W. H. Pope, Hon. A. A. Macdonald, Hon. G. Coles, Hon. T. H. Haviland, and Hon. E. Whelan for Prince Edward Island; and Hon. F. B. T. Carter and Hon. Ambrose Shea for Newfoundland.

The eastern delegates decided that the proposal to unite the maritime provinces under one government and legislature was impracticable, and, though the project has often been revived, three separate eastern legislatures are still maintained. This cleared the ground for the larger issue. The delegates from the two Canadas intervened in the deliberations and the result was a unanimous agreement that union of all the provinces was feasible and desirable, and that a further conference should be held at Quebec to consider the project of union in all its details.

The Canadian delegates were generously entertained at Charlottetown, Halifax, and St. John. Many addresses were delivered at public banquets in advocacy of confederation with a favourable effect upon public opinion throughout the country. Sir John Macdonald said at Halifax: "If we allow so favourable an opportunity to pass it may never come again; but I believe we have arrived at such a conclusion in our deliberations that I may state, without any breach of confidence, that we all unitedly agree that such a measure is a matter of the first necessity, and that only a few (imaginary, I believe) obstacles stand in the way of its consummation. I will feel that I shall not have served in public life without a reward, if before I enter into private life, I am a subject of a great British American nation, under the Government of Her Majesty and in connexion with the Empire of Great Britain and Ireland." It never was the fortune of Sir John Macdonald to enter into private life, but his political aspiration was realised, and he rejoiced and built firmly upon the foundations which were begun at Charlottetown. The language of Sir John Macdonald was also the language of George Brown, his stern and resolute antagonist in Upper Canada, with whom he united for a great object, and who was not less devoted to a union of Canada within the Empire. If British sentiment is rooted deeply in Canada, to Brown and Macdonald falls eternal recognition and gratitude.

The maritime delegates were conveyed to Quebec by the Canadian Government steamer *Victoria*. There, on October 10th, 1864, the Conference reassembled, and practically completed the union of the British American provinces. The delegates were sumptuously enter-

tained at the ancient capital. Subsequently they visited Montreal, Ottawa, Kingston, and Toronto as the guests of the Government. At Ottawa, selected by Queen Victoria as the capital of Canada, they saw the parliament buildings, of which the cornerstone had been laid by King Edward, nearing completion, and there, until their destruction by fire in 1916, the Senate and Commons deliberated upon the problems of the new commonwealth, in unflinching attachment to Great Britain and in sedulous cultivation of national unity and the propagation of a robust national spirit. At the banquet to the eastern delegates at Montreal, there was a verse on the toast list which survives as a sentiment, if not as literature:

"Then let us be firm and united,
One country, one flag for us all;
United, our strength will be freedom,
Divided, we each of us fall."

At the banquet in Toronto one of the speakers was Colonel George T. Denison, who, at the time of writing, with unabated enthusiasm and vigor at eighty-three years of age, still proclaims a united Canada and a united Empire. None of the leaders of the union movement remains. George Brown died in 1880, Sir John Macdonald in 1891, and Sir Charles Tupper in 1915. While no man made greater sacrifices for confederation than George Brown, and no one was more signally influential in overcoming disaffection in the Atlantic provinces and reconciling dissentient factions to the union than Tupper, without Sir John Macdonald and Sir George Cartier, federation could not have been achieved, for Macdonald was trusted by Quebec, and Cartier was able to enlist the powerful support of the Roman Catholic bishops of Lower Canada.

We have had serious difficulties to overcome in the organisation and unification of Canada. A wide gap of unsettled territory separates the east from the west. We have two races and two languages, and an almost equal division of the people between two great systems of religion. In Europe, movement of population from one country to another is obstructed by differences of language and of customs. There is not much in common between the civilisations of Europe and of Asia. Out of race feeling springs national feeling and national cohesion. But Canada is separated from the United States only by a lake, or a river, or a landmark. We and our neighbors speak the same language. We have the same traditions and the same customs. We have common ideals and common institutions. Thus there are influences within and influences without which make our national problem difficult. We have natural social relations with the United States. We are affected by the efficiency and productive capacity of American

industries. For a time we received as many immigrants as entered the United States when the neighboring country had 25,000,000 of population, and we meet the settlers at the frontier with the franchise. We have had a long conflict over fiscal policy. The west, which as yet is chiefly devoted to agriculture, desires lower tariff and freer access to American markets. The east, which has become the seat of manufactures, demands a degree of protection against American industries and even against British imports. The banking and railway corporations have their head offices in the older provinces, and the fact breeds suspicion in the western communities. But despite these conditions, there is a reserve of national spirit in the people which in every crisis holds the country to steady courses and ensures a judgment in the national interest.

It would not be true to say that at the moment there is acute feeling between east and west, for in older Canada there is no sentiment of hostility to the prairie provinces; but in Manitoba, Saskatchewan, and Alberta, there has been a revolt among farmers against the customs duties maintained for revenue and for the protection of eastern industries. The organised farmers insist that the primary industries are burdened by the protectionist tariff, and demand removal of the duties on the tools of production, reciprocity with the United States in goods and products which the United States will admit free of duties, immediate increase of the British preference to fifty per cent., and complete free trade with Great Britain by gradual advances over a five-year period. They also desire taxes on unimproved land values and natural resources, a graduated income tax on the profits of corporations, proportional representation, and "public ownership and control" of railway, water, and aerial transportation. The official Liberal platform closely resembles that of the farmers, but in office its leaders have been unable to reduce duties much below the level established and maintained for years by the protectionist Conservatives.

As a class the farmers of Canada are of conservative temper, of high intelligence, and of national outlook. In the west there are many Americans among the organised grain-growers. Not a few of these were politically active in the states from which they came. They are as active in the western Canadian provinces and influential in the agrarian movement. So in the older provinces there are many Americans among the industrial leaders; but the mass of Americans in Canada are not distinguishable in political action and outlook from the native Canadian element of the population. Naturally, they have no inherited loyalty to Great Britain, but they accept the connexion with the Empire as a fundamental condition of Canadian citizenship. This is a fact of high significance, for unquestionably the movement of American

settlers and American capital into Canada will continue and increase. It is significant, too, that the political platform of the United Farmers requires that all fiscal concessions to other countries shall be extended to Great Britain.

The most powerful section of organised labour in Canada is affiliated with the American Federation of Labour. There is a Canadian labour body and a national Catholic Labour Party in Quebec, but the railway federations and the unions under control of the Dominion Trades and Labour Congress are international. They contributed materially to the defeat of the One Big Union in Winnipeg and other western communities. They were the only unions recognised at the Industrial Conference at Ottawa a few years ago, and although they contain a considerable admixture of radicals and socialists, are opposed to revolutionary courses and "direct action" to achieve their objects. There is, however, an Independent Labour Party dissociated from the international organisation, but whose policy has the general support of the international unions. During the war there was very little industrial conflict in Canada. The official leaders of labour were active in recruiting and in all relief and patriotic movements. They co-operated with employers in production of munitions and responded to all reasonable demands upon their industry and patriotism. There are still, perhaps, many employers who are reluctant to "recognise" unions, but few who attempt to penalise unionists or refuse to bargain with their workmen. Plant councils become common, as do projects of profit-sharing, of group insurance, of stock distribution, and of many other devices to ensure co-operation, to improve working conditions, and to reward efficiency. And in the general attitude of employers there is, beyond all considerations of profit, a genuine desire to establish the human relation with employees which gives security to the individual, stability to industry, and strength to the commonwealth.

Unfortunately, the war produced friction between Quebec and the English provinces but this now is generally deplored, recrimination has almost ceased, and the wounds heal slowly, perhaps, but surely. There is, unquestionably, a sincere and even anxious desire among the masses of the English-speaking people that Quebec shall have adequate authority in government, that every constitutional right and privilege of the French minority shall be respected, that their language shall not be proscribed in any portion of the Confederation, and that their virtue and valour shall be honoured. The French constitute one-third of the population of Canada, and it is vital to national unity and stability that they shall not be politically isolated nor permanently isolate themselves from the common interests and common responsibilities of the country.

In the space of a few years there have been great social changes in Canada. Equal suffrage has been established in federal elections, and in all the provinces but Quebec; and the retail sale of liquor is prohibited in five of the nine provinces. We have a new status in the Empire, and representation in the Assembly of Nations; but there is even closer attachment to Great Britain and ungrudging assumption of the duties and responsibilities of Empire. We have, too, a clearer conception of the delicacy and gravity of international relationships. We understand as never before that we must interpret the British Empire to other nations of this continent, and bring, so far as we may, the English-speaking peoples together in enduring amity and concord. When the war came, we had to provide annually for federal purposes between $170,000,000 and $175,000,000. For the future we shall have to raise annually between $300,000,000 and $350,000,000. We had a debt of $336,000,000, which has been increased to $2,400,000,000. But we have rich resources, a thrifty and energetic people, pride in what we have accomplished, and confidence that the burden is not greater than we can carry, and that the vision which we cherish of a sober, self-reliant, united, prosperous democracy in intimate alliance with the old Mother of Freedom oversea will have increasing realisation in the years of strain and endeavour, of achievement and triumph, which lie in the future.

THE INDIANS OF CANADA

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Not the least interesting group of the inhabitants of Canada are the natives of the country. They number now more than one hundred thousand and are scattered from one sea-board to the other, yet a traveller might make an extensive tour throughout the country without seeing a single red man. Although they are occasionally found on the streets of our cities, the large majority of the Indians reside on reserves more or less remote from the centres of population, and numbers of them are hunters who spend most of their time in the forests on their ancestral hunting grounds.

It will be interesting to note that the present policy and usage with reference to the Indians of Canada sprang from the administration of Sir William Johnson, who was Superintendent General of Indian Affairs in the old colony of New York. He had to deal with uncivilised Indians, and his policy was "to put forth measures adapted to win upon their affections, to coincide with their genius and dispositions, to discover all their designs, to prevent frauds and injustice, to redress grievances, to remove their jealousies and apprehensions".

This difficult task was carried out by a strict recognition of the Indians' rights to their territories, and although the right of the Crown was paramount, the British always recognised the underlying Indian title.

After the conquest of Quebec the same policy was extended to the conquered country, and the Proclamation of 1763 guaranteed that no Indian should be molested or disturbed without a cession of his territories or hunting grounds, and thus it happens that a large proportion of the lands of Canada have been surrendered by the Indians, who have received compensation for their aboriginal title.

For 70 years after the cession of Canada, Indian administration was in the hands of the Imperial military authorities; it was not until 1835 that the responsibility was transferred to the Province of Canada. The military policy had looked upon the Indians as potential allies or foes, and, during the pioneer days, the feeling was balanced between hope and apprehension. They were kept quiet by presents of scarlet cloth, silver gorgets, brass kettles, and ammunition, with an occasional

ration of rum. The fur-traders used the latter fluid as the most precious means of exchange and barter, and the restless, dejected people that were handed over to the province were indeed a problem. One governor of Upper Canada, seeing them so wretched, resolved to send them back to Nature for healing, and to remove them to hunting grounds where they might recuperate or die away unseen. But better counsels prevailed. The missionaries claimed the Indians as material ready for evangelisation, and protested that they were capable of lasting improvement. Upper and Lower Canada, not long after that, began a systematic endeavour to educate the Indians, supported by zealous missionary effort. This informal union between church and state still exists, and all Canadian Indian schools are conducted upon a joint agreement between the government and the denomination as to finances and system. The method has proved successful, and the Indians of Ontario and Quebec, in the older regions of the provinces, are every day entering more and more into the general life of the country. They are farmers, clerks, artisans, teachers, and lumbermen. Some few have qualified as medical doctors and surveyors; an increasing number are accepting enfranchisement and taking up the responsibilities of citizenship.

The following table gives the native population of Canada by provinces:

DISTRIBUTION OF ABORIGINES IN CANADA

Alberta	8,837
British Columbia	25,694
Manitoba	11,583
New Brunswick	1,846
Nova Scotia	2,031
Ontario	26,411
Prince Edward Island	292
Quebec	13,366
Saskatchewan	10,646
Northwest Territories	3,764
Yukon	1,528
Total	105,998
Eskimos	3,290

It will be observed that Ontario has the largest Indian population. At least 50 per cent. of the total of Indians in that province are dependent for a livelihood to a greater or lesser degree on hunting and fishing. A variable percentage in each province is likewise so dependent. This is the natural manner of life for the Indian, and although he is by no means superior to the white man even in this, his native pursuit, he is yet the most important source of supply to the fur-trader. In British Columbia he is a highly important factor in the labour of the salmon fishery, not only in the taking of the fish, but in the preparation in the canneries of the product for the market.

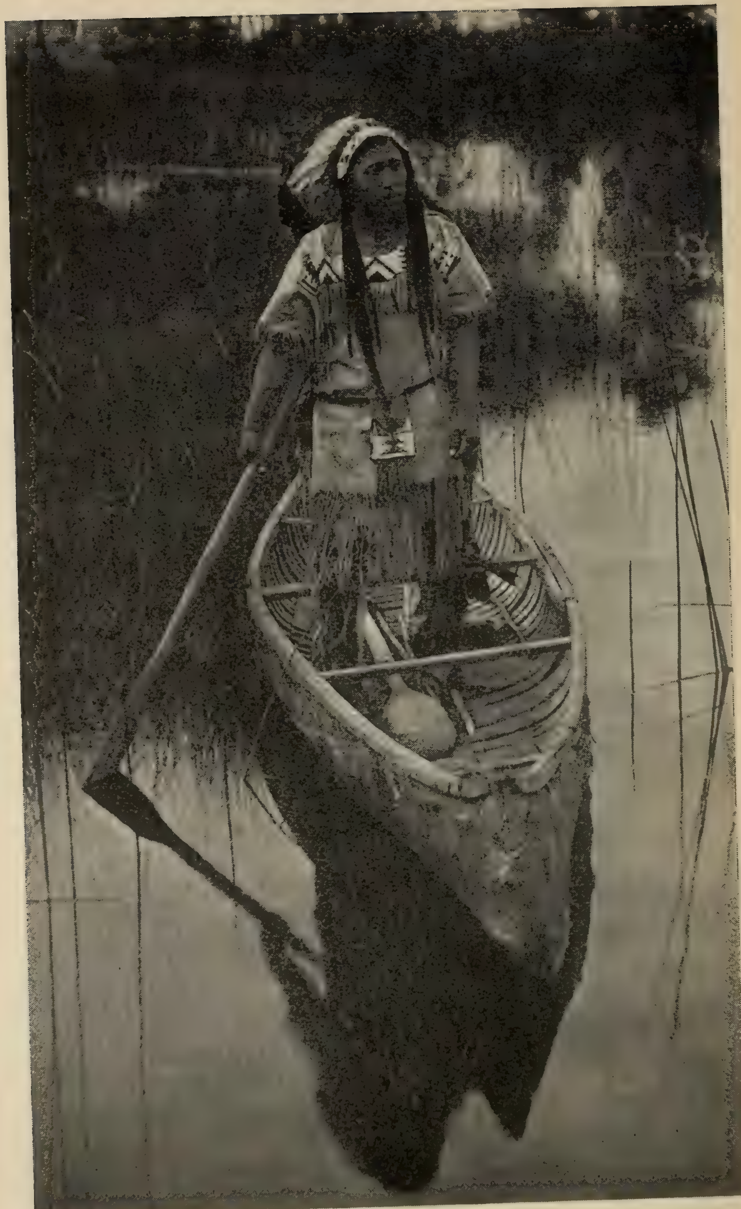

FIG. 1. ALBERT WAHBUNOSA, PAU-PUK-KEEWIS

Although the value of the furs and fish taken by the Indians is in the annual aggregate very large, the Indians are coming more and more to be an asset to the country in grain-production and cattle-raising. Last year they harvested 1,689,284 bushels of wheat, oats, and other grains, and they produced 580,000 bushels of potatoes and other roots. The Indians own 50,197 head of cattle and 41,722 horses. Their reserves comprise 4,911,259 acres, and the value of their real and personal property is estimated to be $69,708,000.00.

It will be gathered from these figures that the natives of this country are in an enviable position. The close supervision which the government officers have given them from the earliest times has resulted in conserving their estate and developing their aptitude for civilised life. The policy of the Dominion has always been to protect the Indians, to guard their identity as a race and at the same time to apply methods which will destroy that identity and lead eventually to their disappearance as a separate division of the population.

At Confederation the wise policy was adopted of placing all the Indians of the country under the federal authority, and the Dominion Parliament alone has legislative power with reference to Indians and lands reserved for the Indians. The laws with reference to Indians, which were passed before Confederation, were afterwards consolidated and have from time to time been added to. They provide full protection for the Indian and his property. No trespass is allowed on reserves, no intoxicating liquor can be sold, the descent of property is provided for, the revenues and expenditures are governed by enactments, and finally provision is made for the enfranchisement of any Indian who has advanced beyond the need of further wardship. Enfranchisement carries with it full ownership of his share, if any, of the lands and monies of his tribe and full rights of citizenship. Enfranchisement is sometimes confused with the exercise of the franchise. In provincial elections no Indian residing in Manitoba, Saskatchewan, Alberta, British Columbia, or New Brunswick, has the right to vote, but in the other provinces, if he does not reside on a reserve, and is otherwise qualified, he may vote. In Dominion elections those Indians only who do not live on reserves or follow the Indian mode of life or who served in the late war can vote.

The Eskimos, who number about 3,300, are also a very interesting native group in the Dominion, in fact they inspire respect by their vigorous spirit and industry. As their habitat is remote, their association with the administration is not so close as that of the Indian, and but little has been done for them in the way of education, although a general supervision is kept up through the posts and officers of the Royal Canadian Mounted Police.

THE GROWTH OF POPULATION IN CANADA

R. H. Coats, F.S.S., F.R.C.S.
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It is interesting to note that to Canada probably belongs the credit of taking the first census of modern times. In 1665 a systematic "nominal" enumeration of the population of the colony of New France was made, on the *de jure* principle, showing age, sex, occupation, and conjugal and family condition. The results, occupying 154 pages in manuscript in the Archives at Paris, showed some 3,215 souls. Two years later a supplementary inquiry covered areas under cultivation and the numbers of sheep and cattle.

This early investigation was repeated at intervals for nearly one hundred years, or until the British conquest. By the end of the seventeenth century Canada's population reached over 15,000, and this was doubled by 1725. When the country passed under British rule in 1763 the population of New France was about 70,000, and another 10,000 French were scattered through what is now the maritime provinces, where they mingled with a British population about equal in numbers.

After the conquest, census-taking became more irregular. British settlement in Ontario may be said to date only from the Loyalist movement which followed the American Revolution. Canada began the nineteenth century with a population of perhaps a quarter of a million. Some representative figures of the next half century are as follows:

Population of Canadian Colonies, 1817-1844

Upper Canada	(1824)	150,069
" "	(1840)	432,159
Lower Canada	(1822)	427,465
" "	(1844)	697,084
New Brunswick	(1824)	74,176
" "	(1840)	156,162
Nova Scotia	(1817)	81,351
" "	(1838)	202,575
P. E. Island	(1822)	24,600
" "	(1841)	47,042

The end of desultory census-taking came with an Act of the United Provinces dated 1847 creating a "Board of Registration and Statistics" with instructions to "collect statistics and adopt measures for dissemi-

nating or publishing the same," and providing for a decennial census. Thus from 1851 we have regular decennial statistics for the settled portions of the areas now included in the Dominion of Canada. The record by provinces is shown in the accompanying table. It will be noted that the 'fifties showed a rapid growth, especially in Ontario, and that the rate kept up both in the 'sixties and 'seventies. The two next following decades, however, did not maintain this progress, though at the end of the nineteenth century Canada had reached a population about midway between 5,250,000 and 5,500,000.

POPULATION OF CANADA, 1851–1881

PROVINCES	1851	1861	1871	1881
Prince Edward Island..	66,000[1]	80,857	94,021	108,891
Nova Scotia..........	276,854	330,857	387,800	440,572
New Brunswick.......	193,800	252,047	285,594	321,233
Quebec..............	890,261	1,111,566	1,191,516	1,359,027
Ontario..............	952,004	1,396,091	1,620,851	1,926,922
Manitoba............	......	......	25,228	62,260
Saskatchewan........	......	......	......	......
Alberta..............	......	......	......	......
British Columbia......	......	......	36,247	49,459
Yukon...............	......	......	......	......
Northwest Territories..	6,000[1]	15,000[1]	48,000[1]	56,446
Total...........	2,384,919	3,156,418	3,689,257	4,324,810

[1]Estimated.

POPULATION OF CANADA, 1891–1921

PROVINCES	1891	1901	1911	1921
Prince Edward Island..	109,078	103,259	93,728	88,615
Nova Scotia..........	450,396	459,574	492,338	523,837
New Brunswick.......	321,263	331,120	351,889	387,876
Quebec..............	1,488,535	1,648,898	2,003,232	2,361,199
Ontario..............	2,114,321	2,182,947	2,523,274	2,933,662
Manitoba............	152,506	255,211	455,614	610,118
Saskatchewan........	......	91,279	492,432	757,510
Alberta..............	......	73,022	374,663	588,454
British Columbia......	98,173	178,657	392,480	524,582
Yukon...............	......	27,219	8,512	4,157
Northwest Territories..	98,967	20,129	18,481	7,988
Total............	4,833,239	5,371,315	7,206,643	8,788,483

Twentieth Century Expansion.—The following brief review of the movement of population in Canada during the twentieth century and of the main results of the census of 1921 is from the current issue of the Canada Year Book:

"It is within the confines of the present century that the most spectacular expansion of the Canadian population has taken place. The outstanding feature was, of course, the opening to settlement of the "last best west." The unorganised territories of British North America had been ceded to the Dominion soon after Confederation, and the west had been tapped and traversed by the Canadian Pacific

Railway in the 'eighties and 'nineties. But though western population doubled with each of these decades, it was only with the launching of a large-scale immigration movement after 1900 that western settlement and production became a first-rate economic factor. Simultaneously an almost equally striking development occurred in the industrial centres of eastern Canada, which formed the immediate basis for the move upon the west. At the back, of course, was the heavy inflow of British capital—a total of two and a half billions of dollars within a dozen years—which went to finance the large constructive undertakings (chiefly railway and municipal) which characterised the movement and which represented at bottom the traditional policy of England in search of cheap and abundant food for her workshop population. The years 1901 to 1911, in brief, form the *decas mirabilis* of Canadian expansion. The immigration movement just mentioned, which had previously run well under 50,000 per annum, rose rapidly to over five times that volume, eventually passing 400,000 in a single year. In the ten years 1901 to 1911 it totalled over 1,800,000, and though at least a third of these were lost (partly in the return to Europe of labour temporarily attracted by the railway and other developments in progress, and partly in the never-ceasing and natural "drag" of the United States upon a virile and less wealthy people), it formed the chief factor in the gain of 34 per cent. which the total population of Canada registered in that decade, and which was larger than the relative growth of any other country during the same period. The movement was continued and even intensified in the first three years of the second decade of the century, after which a recession set in to which the outbreak of the war gave a new and wholly unexpected turn. Nevertheless the decade which closed with the census of 1921 again showed over 1,800,000 immigrant arrivals in Canada, and though the proportionate loss of these was very heavy (probably as much as two-thirds), Canada's relative gain for the decade was again all but the largest in the world.

"*The Census of 1921.*—According to the final results of the 1921 census, the total population of the Dominion on June 1, 1921, was 8,788,483, as compared with 7,206,643 on June 1, 1911, an increase of 1,581,840 or 21.95 per cent. in the decade, as compared with 34.17 per cent. during the decade from 1901 to 1911. Reduced as is the rate of increase during the past ten years, it is higher than the rate of increase in any other of the principal countries of the British Empire except Australia, where the rate was only slightly greater, and considerably higher than that of the United States.

"The countries which comprise the British Empire, as also the United States, have on the whole suffered much less in actual loss of

life from the war and its consequences than have the continental countries of Europe. None of them has actually declined in population during the period, as many continental European countries have done. Their percentage increases, however, have in almost all cases been lower than in the previous decade. Thus the population of England and Wales increased between 1911 and 1921 only from 36,070,492 to 37,885,242, or 4.93 per cent., as compared with an increase of 10.89 per cent. in the previous decade; Scotland, again, increased only from 4,760,904 to 4,882,288, or 2.5 per cent., as compared with 6.5 per cent. between 1901 and 1911.

"Of the oversea Dominions, New Zealand increased from 1,008,468 to 1,218,270 or 20.8 per cent., as compared with 30.5 per cent., while the white population of South Africa increased from 1,276,242 to 1,522,442 or 19.3 per cent. On the other hand, the Commonwealth of Australia, the only Dominion to grow more rapidly in the second decade of the twentieth century than in the first, increased from 4,455,005 in 1911 to 5,436,794 in 1921, or 22.04 per cent., as compared with 18.05 per cent. The population of the continental United States increased between 1910 and 1920 from 91,972,266 to 105,710,620, an increase of 14.9 per cent. as compared with 21 per cent. in the preceding decade."

The preponderance of the western provinces in the recent growth of population in Canada may be readily deduced from the table on page 21. In the decade 1911-1922 the western increase was 44.2 per cent., compared with an increase of only 15 per cent. in the five eastern provinces. In 1871 less than 3 per cent. of the Canadian population dwelt west of the Lake of the Woods; to-day the percentage is 28.

Analyses of Growth of Population.—There are, of course, numerous analyses of the population that demand a reference even in the briefest of treatments. The more important are summarised below:

Sex Distribution—The excess of female over male population, which characterises the older countries of the world, is not found in Canada. From the earliest times there has been a preponderance of male population, due largely to the larger number of males among immigrants. In 1665 there were 2,034 males to only 1,181 females. A century and a quarter later there were 54,064 males to 50,759 females. In the middle of the nineteenth century there were 449,967 males to 440,294 females in Lower Canada and 499,067 males to 452,937 females in Upper Canada. The heavy immigration of the twentieth century has further raised the "masculinity" of the Canadian population, though there has been a decrease during the last ten years, due doubtless to the war. In 1921 there were 515 males to 485 females in each 1,000 of the population.

Age Distribution—Age distribution has also been affected by the conditions just noted. In the first stages of settlement a disproportionately large male population between the ages of 20 and 50 together with a low birth rate are to be expected. Later the rate of natural increase goes up and there is a larger proportion of children in the population. In 1871 no fewer than 287 of every 1,000 of the population of Canada were children over 10 years of age, whilst over one-half of the total population were under 20 years of age. With growing urbanisation the average age at marriage has increased; nevertheless in 1921, 240 per 1,000 of the Canadian population were under 10 years of age and 435 per 1,000 under 20 years. The median Canadian age in 1921 was 23.943 years, whereas in 1871 the median was 18.79.

Conjugal Conditions—The larger percentage of married in recent years is the outstanding feature, mainly attributable to the larger percentage of adults to the total population.

Racial Origins—The problem of basic ethnic stocks and their assimilation is an important factor in the growth of the Canadian population. Analysis of this complex phenomenon may be made from the annexed table. The increase in the British and French races during the past decade accounts, it will be seen, for more than 86.5 per cent. of the total increase.

ORIGINS OF THE PEOPLE ACCORDING TO THE CENSUSES OF 1871, 1881, 1901 1911, and 1921

Origin	1871	1881	1901	1911	1921
British—	No.	No.	No.	No.	No.
English	706,369	881,301	1,260,899	1,823,150	2,545,496
Irish	846,414	957,403	988,721	1,050,384	1,107,817
Scotch	549,946	699,863	800,154	997,880	1,173,637
Other	7,773	9,947	13,421	25,571	41,953
Total British	2,110,502	2,548,514	3,063,195	3,896,985	4,868,903
French	1,082,940	1,298,929	1,649,371	2,054,890	2,452,751
Austrian	......	......	10,947	42,535	107,671
Belgian	......	......	2,994	9,593	20,234
Bulgarian and Roumanian	......	......	354	5,875	15,235
Chinese	......	4,383	17,312	27,774	39,587
Czech (Bohemian and Moravian)	......	......	......	......	8,840
Dutch	29,662	30,412	33,845	54,986	117,814
Finnish	......	......	2,502	15,497	21,494
German	202,991	254,319	310,501	393,320	294,636
Greek	......	......	291	3,594	5,740
Hebrew	125	667	16,131	75,681	126,196
Hungarian	......	......	1,549	11,605	13,181
Indian	23,037	108,547	127,941[1]	105,492	110,596
Italian	1,035	1,849	10,834	45,411	66,769
Japanese	......	......	4,738	9,021	15,868
Negro	21,496	21,394	17,437	16,877	18,291
Polish	......	......	6,285	33,365	53,403
Russian	607	1,227	19,825	43,142	100,064
Scandinavian[2]	1,623	5,223	31,042	107,535	167,359
Serbo-Croatian	......	......	......	......	3,906

Swiss	2,962	4,588	3,865	6,625	12,837
Turkish	......	......	1,681	3,880	313
Ukranian—Bukovinian...	......	......	[3]	9,960	1,616
Galician...	......	......	5,682	35,158	24,456
Ruthenian.	......	......	[4]	29,845	16,861
Ukranian..	......	......	......	......	63,788
Various	1,220	3,952	1,454	20,652	18,915
Unspecified	7,561	40,806	31,539	147,345	21,249
Grand Total...	3,485,761	4,324,810	5,371,315	7,206,643	8,788,483

[1]Includes "half-breeds". [2]Includes Danish, Icelandic, Norwegian, and Swedish. [3]Included with Austrians. [4]Included with Galicians.

Birthplace—Nativity is of kindred interest. In 1871, 97.2 per cent. of the population had been born under the British flag; half a century later the percentage had declined to 87.9. The Canadian-born population was at its maximum in 1901 with 86.9 per cent. of the total, but at its minimum in 1921 with 77.7 per cent. United States-born population has increased from 1.8 per cent. in 1871 to 4.26 per cent. in 1921.

Rural and Urban—Canada is predominantly an agricultural country, yet it has reached the point where its town dwellers all but equal the numbers upon the land. Indeed it has probably passed that stage, as the census reckons only fully incorporated villages and towns as "urban". Yet only forty years ago the towns and cities of Canada accounted for but 14 per cent. of the people, and at the beginning of the present century the percentage was only 37. The expansion of 1900-1910, as already remarked, though based on the opening of the west to agriculture, was no less remarkable for the growth of the cities—in fact the urban increase of the decade was more than double the rural (1,258,645 compared with 574,878), whilst the proportion of city population to the total moved up from 37 to 45. That after the initial settlement of a new country there should follow a period of town development to meet its business needs is natural enough—such was the experience in earlier Canadian history—but that urban growth should parallel and "overshoot" rural in a period like that of the settlement of the west is significant of much in recent Canadian history. To enlarge upon this: Ontario and the three maritime provinces actually lost in rural population during the decade 1901-1911. The loss was in part a movement of farmers towards the new western lands, but it was also a trek townwards, and particularly to the larger cities. In 1901 only 12 per cent. of the Canadian population was in cities of over 50,000 people; in 1911 the percentage was 18, whilst the ten largest cities alone absorbed more than half of the entire urban gain of the decade. Not all of this accretion came from the land, for at least 150 small towns and villages lost population.

The same tendencies have been at work in the decade just closed, though only Nova Scotia, Prince Edward Island, and Quebec have declined in actual numbers of rural population. Nova Scotia's total gain as a province is largely accounted for by Halifax, Sydney, and the Pictou section. In the older parts of Ontario a score of counties has declined, and so has the majority of the small towns and villages. One-half of the entire growth of the province is in Toronto and the surrounding districts, and most of the remainder in Hamilton, the towns adjacent to Niagara power, the Windsor group of cities in the west, and Ottawa in the east. Montreal, Three Rivers, and Sherbrooke form the counterpart for Quebec, with some rural growth in Chicoutimi-Saguenay and Pontiac corresponding to similar expansion in New Ontario. In the west, Manitoba is depleting her small towns to feed Winnipeg and St. Boniface, which two cities account for one-third of the provincial increase, though there has been about an equal increase upon the land. Saskatchewan and Alberta similarly are building up their cities, but they are also increasing their rural population, though somewhat less rapidly from a relative standpoint. In British Columbia, Vancouver and Victoria account for 30,000 increase of a total of 132,000, but there has been growth upon Vancouver island.

For the first time in its census history Canada now possesses cities of half a million population, these being Montreal and Toronto. No other city has attained the 200,000 mark, but during the past decade Hamilton and Ottawa have been added to Winnipeg and Vancouver as cities of 100,000 population.

Dwellings and Families—The average number of persons per family in 1921 was 4.62 as compared with 4.85 in 1911 and 5.03 in 1901, indicating a continued decline in the average number of persons constituting a household. The average number of persons per dwelling in 1921 was 4.96 compared with 5.11 in 1911 and 5.23 in 1901; this would imply that the Canadian people are more adequately housed to-day than in the past.

IMMIGRATION AND LAND SETTLEMENT IN CANADA*

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The study of Canada's immigration and land settlement problems, and the processes by which these problems are being solved, is of peculiar interest to residents in all parts of the British Empire. Canada, the largest in point of area of the British nations, and the one lying nearest to the motherland, inherited the task of blazing a path through a field of new experiences. In this task she has achieved some success and has, no doubt, to acknowledge some failures. But both the success and the failure lie in the way of human advancement, and that the success outweighs the failure must be readily evident to all observers.

Canada's land settlement policies are of far-reaching interest and effect, not only to the people of the Dominion and of the British Empire, but also to the outside world. At no point, perhaps not even in the matter of international trade relationships, does Canada come into more intimate contact with her national neighbours than in the framing and application of her immigration policies. When it is remembered that Canada, with one-sixteenth of the world's land area and probably more than one-sixteenth of its natural resources, has as yet only about one-half of one per cent. of the world's population, the part which immigration is destined to play in the future development of the Dominion and the re-action which it will have upon other countries are somewhat appreciated.

Canada's development has been, and is, inseparably interwoven with immigration. All that Canada is to-day she is because of the immigrants who have come to her shores, and every citizen who does not trace his ancestry to the original natives is either an immigrant or the descendant of immigrants. It has been by this flow of population from other lands that the development of Canada to its present status has been achieved.

This development, until about the beginning of the present century, was largely of an undirected character. Led by the spirit of adventure or the desire for self-betterment, individuals and groups migrated to Canada from portions of the United States, from most of the countries of Europe, but most particularly from the British Isles. Impetus

was given to such movements from time to time by unusual or artificial conditions, for example, the state of affairs which prevailed in the new American Republic at the close of the Revolutionary War, when large numbers of loyalists migrated to Nova Scotia, New Brunswick, and portions of Ontario and laid the foundations of what is now the most permanent Canadian stock of Anglo-Saxon ancestry; but for the most part the movements were small, detached, and unorganised. To sketch in any detail the history of early immigration to Canada would be virtually to recount the history of the country from the discoveries of Cabot, Cartier, and Champlain to modern times, but it is actually within the last fifty years that the greatest increases in Canada's population have occurred. In 1871—four years after the consummation of Confederation and 331 years after the first attempt to plant a colony in Canada—the population of the entire country did not exceed 3,690,000. The increase in population during the decade 1871 to 1881 was 635,000; during the decade 1881 to 1891 it was 508,000; and from 1891 to 1901 it was 538,000.

It was not until the first decade of the twentieth century—aptly described by Sir Wilfred Laurier as Canada's century—that the decennial returns showed an increase in population exceeding one million souls. This period also marks the adoption, or at least the fructification, of a vigorous and deliberate policy toward filling up the vacant spaces of Canada with human beings. The keystone of that policy was free land, but closely associated with it was the immense development which characterised the first dozen years of the new century. This development took many forms; it embraced the building of extensive railways, elaborate irrigation systems, and young but ambitious cities. Labour was to be found for all, and the flood of population, while fundamentally dependent upon the settlement and development of the farm lands of the country, flowed in a considerable volume into railway camps, lumber woods, and the various channels for rough and skilled labour afforded by the rapidly growing cities and towns.

The policy of granting free land to those who would undertake to live upon it was, of course, no new experiment. The first land in western Canada granted under such a policy was filed upon on July 2nd, 1872—just a little more than a half-century ago—and the considerable degree of development which had occurred in Manitoba previous to the year 1900 was largely the outcome of that policy of free land for settlers. Closely associated with the free land grants was the practice established by the Canadian Pacific Railway and in a lesser degree by the Hudson's Bay Company of selling the immense areas of land which had come into their possession by virtue of their agreements with the Government at prices so low and on terms so

generous that it became a saying that in many cases the purchased lands were as cheap to the settler as those which were granted free.

A glimpse in detail at the Canada-ward movement of population during the high-tide period which met a sudden ebb with the outbreak of the great war may prove of interest:

IMMIGRATION TO CANADA FROM THE BEGINNING OF THE TWENTIETH CENTURY TO THE OUTBREAK OF THE GREAT WAR

		Great Britain	U.S.A.	Other countries	Totals
Fiscal year ended June 30th,	1901	11,810	17,987	19,352	49,149
" " " " "	1902	17,259	26,388	23,732	67,379
" " " " "	1903	41,792	49,473	37,099	128,364
" " " " "	1904	50,374	45,171	34,786	130,331
" " " " "	1905	65,359	43,543	37,364	146,266
" " " " "	1906	86,796	57,796	44,472	189,064
Nine months ended March 31st,	1907	55,791	34,659	34,217	124,667
Fiscal year ended March 31st,	1908	120,182	58,312	83,975	262,469
" " " " "	1909	52,901	59,832	34,175	146,908
" " " " "	1910	59,790	103,798	45,206	208,794
" " " " "	1911	123,013	121,451	66,620	311,084
" " " " "	1912	138,121	133,710	82,406	354,237
" " " " "	1913	150,542	139,009	112,881	402,432
" " " " "	1914	142,622	107,530	134,726	384,878
		1,116,352	998,659	791,011	2,906,022

The close association which existed between the movement of population and the issue of free lands is indicated by the following table showing the number of entries for homesteads during the same period:

TABLE OF HOMESTEAD ENTRIES

Fiscal year	1901	8,167
" "	1902	14,673
" "	1903	31,383
" "	1904	26,073
" "	1905	30,819
" "	1906	41,869
Nine months ended March 31st,	1907	21,647
Fiscal year	1908	30,424
" "	1909	39,081
" "	1910	41,568
" "	1911	44,479
" "	1912	39,151
" "	1913	33,699
" "	1914	31,829
Total		434,862

It will be noted that the homestead entries reached their peak in 1911 and the immigration movement two years later, in 1913. Two conclusions are suggested by this fact; first, that the accessible homestead lands were being exhausted, and second, that the wave of development which accompanied their settlement had increased the demands for non-agricultural immigrants until they represented a greater proportion of the whole than in the earlier stages of the movement.

Indications that the wave of immigration, for the time being at least, had passed its crest, were not lacking in the latter part of 1913 and the earlier part of 1914, before the sudden outbreak of war interjected a new and unforeseen factor. Immigration from the enemy countries, of course, was suspended immediately and completely, and

FIG. 2. KNOWLTON, EASTERN TOWNSHIPS OF QUEBEC
The centre of a rich farming country.

from Great Britain and her allies practically so, the movement from the United Kingdom dropping from 142,622 in the year ended March 31st, 1914, to 8,664 in the year ended March 31st, 1916. The movement from the United States was similarly, although not so seriously affected, dropping in two years from 107,530 to 36,937. While the United States remained neutral, Canada as a warring nation was at an obvious disadvantage as a field for new settlers, and after the United States cast in its lot in the war the magnitude of the preparations undertaken had a similar effect on immigration returns. The lowest figures in Canada's immigration since the beginning of the present century were touched in 1916, and from then until 1920 the yearly arrivals were only about 25 per cent. as numerous as during the years immediately preceding.

Many opinions were held as to the probable trend of events in relation to immigration after the close of the war, and there was a

general anticipation that the movement to Canada would again be very heavy, and probably exceed all previous records. This anticipation was not realised for a number of reasons. Canada, in common with all other countries, experienced a share of the dislocation of business and the industrial uncertainties of the period of reconstruction. The demobilisation of the Canadian forces, coincident with the suspension of all war activities, brought about a surplus of labour in labour markets, which made it impracticable for the Canadian Department of Immigration and Colonization to extend inducements to the vast numbers of labourers available at that time as immigrants. The welfare of the country seemed to demand, as a rule, that only those should be admitted who were in a position to assist in developing its natural resources, chief among which is its fertile agricultural land. Farmers and farm labourers became more than ever the objective of the Department of Immigration and Colonization. Other factors which contributed to the depression of immigration figures, as compared with the period immediately preceding the war, were the high cost of ocean and land transportation and the balance of exchange against the

FIG. 3. DAIRY CATTLE IN ONTARIO

capital of British and European immigrants, coupled with the generally impoverished condition of some of the countries which had formerly been contributors of immigrants, and to the fact that, although great areas of land were still available as free homesteads, they were now

located for the most part at considerable distances from railways. The recent policy of the Department has been not to encourage settlement in localities likely to require the construction of additional railways at an early date.

Most of the restrictive regulations that were found necessary during the period of reconstruction have now been cancelled, but they undoubtedly created in the minds of many people abroad doubt as to their welcome to Canada and their ability to meet the standards set up. During 1923 it became increasingly evident that popular opinion in Canada favoured a resumption of immigration activities on a considerable scale and the Government announced its intention of extending its operations with a view to encouraging the migration of the largest possible number of those classes that Canada can absorb. This policy was embodied in a statement made by the Hon. J. A. Robb in September, shortly after his appointment to the position of Minister of Immigration and Colonization, and elicited much favourable comment by the British press, which in general welcomed a resumption of Canadian activities upon a large scale. While, as Mr. Robb pointed out, there are some would-be immigrants into Canada who are not suited for the Dominion owing to physical, moral, or industrial unfitness, or because they belong to races that cannot be assimilated without social or economic loss to Canada, there are at the same time in Great Britain and continental Europe tens of thousands of skilled workers and unskilled workers (not agriculturists) who would be an asset to Canada if steady employment could be found for them.

The immigration policy of the Canadian Government recognises that while Canada requires increased population, quality rather than quantity must count; that British immigration must hold first place in the programme, and that the selection of Canada's new settlers must have due regard to physical, industrial, and financial fitness, and the Dominion's power of absorption.

The greatest need is for those able and willing to settle on the land and assist in agricultural development. While capital is essential to immediate land settlement, its absence will not close the road to prosperity to those strong of hand and stout of heart, determined to succeed.

The open-door policy prevails for those classes likely to succeed and for whom there is a demand. In the interests of the immigrant and of Canada, determination of fitness, as far as possible, takes place before the immigrant leaves his own country.

As the British Isles alone cannot furnish a sufficient quota of the agricultural classes, efforts are being made to encourage immigration from certain areas of the continent of Europe and from the United States.

Steps have been taken to ensure efficient co-operation with the British Government under the terms of the Empire Settlement Act as they apply to affording assistance to those of the agricultural and house-worker classes from the mother country. To promote the better functioning of colonisation activities in Canada the machinery of the Soldier Settlement Board has been co-ordinated with that of the Department of Immigration and Colonisation. This action has placed at the command of the Department a large and well organised staff

FIG. 4. BREAKING VIRGIN PRAIRIE BY TRACTOR

with representatives throughout the Dominion thoroughly conversant with local conditions and able to advise and direct the newcomer to his best advantage.

The fact is fully grasped by the Canadian Government that the new settler is not a success either as related to himself or to the country of his adoption, unless he improves his condition by moving to Canada, or at least, brightens the outlook for his children. It has been well said that the successful settler is the best advertisement of any country's immigration policy, and to promote successful settlement is the immediate objective of the Canadian Department of Immigration and

Colonization. The process of converting the immigrant into a self-supporting Canadian, proud of the opportunities which a new land affords him, proud of his share in developing those opportunities, and conscious of his obligation to society and to the state which made those opportunities possible, lies at the root of Canada's immigration problem. It has been pursued seriously and with a sufficient percentage of success to justify the statement that Canada is in very reality a land of opportunity to those who are willing and able to adapt themselves

FIG. 5. SOIL PACKING AND SEEDING ON THE CANADIAN PRAIRIE

to the conditions which are inseparable from the developmental stage of a new country. Immigration to Canada is limited by no arbitrary rules, but by the ability of the Dominion to absorb additional population. As, with the anticipated return of more and more prosperous times, that ability for absorption increases, the corresponding increase in immigration may be anticipated. That such increases will be beneficial not only to Canada but to the British Empire as a whole and to the world at large and—more important still—to the newcomers themselves, may be predicted with confidence.

SETTLING THE PRAIRIES

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In the summer of 1868 a young Englishman arrived at Fort Garry (Winnipeg) and found a small hamlet outside the walls of the Hudson's Bay Company's trading post and a few hundred settlers along the banks of the Red and Assiniboine rivers. To the westward nearly a thousand miles away lay the Rocky mountains, and the unbroken prairie between was practically uninhabited save for numerous tribes of Indians and herds of buffalo. To-day over that great area the buffalo is extinct save for those in captivity; the Indians with numbers greatly reduced are wards of the nation. Fifteen thousand miles of railway cross and intersect the prairies; the population numbers 2,000,000 souls and the prairie wheat harvest of 1923 totalled 430,000,000 bushels and the total grain crop one billion bushels. But the young English immigrant of '68, now a merchant prince, still directs personally from his Winnipeg office the great business enterprise which he has built up. Thus the transformation period of the Canadian middle west is spanned by one active business career. It is perhaps the most spectacular of the peaceful conquests of the past half-century.

The year 1869 may be regarded as the beginning of modern history west of the great lakes as in that year administrative authority was transferred from the Hudson's Bay Company to the Dominion government at Ottawa. In the following year the Province of Manitoba was established. It is interesting to note that the population of the new province in 1870 was 12,228, of whom it is estimated that all save about 2,000 were Indians or of mixed blood.

The Red River rebellion of the Metis at this period, while serious for the resident settlers, served in a striking manner to direct the attention of eastern Canada and Great Britain to the youthful settlement, and the great unsettled country beyond. There was great diversity of opinion as to the ultimate usefulness of the country, which had been regarded for generations as unsuited for agriculture. A young Scotch soldier, discharged from General Wolseley's command at the close of the rebellion, started farming in 1872 about 20 miles from the Red river. He was the recipient of considerable sympathy and the butt

of good-natured ridicule as the "limit of the wheat belt" was five miles from the river's bank. But the young soldier has grown thousands of bushels of wheat there and is still growing wheat on the same farm. His experience is but typical of that of thousands as they pushed the wheat belt to the north and west.

The little settlement at Fort Garry was far removed from the centres of civilisation, and without railway facilities. But the lure of adventure was steadily turning young men from eastern Canada and the British Isles towards the western prairies. Rich prairie land was free for the taking, land that required no clearing and no fertilisation, and taxes were almost non-existent. One young immigrant from the Orkney Isles who had never expected to own more than three acres homesteaded upon a half section, 320 acres. He walked up and down across his "estate" feeling like a king but wondering what a man could do with so much land. He later quadrupled his acreage and is now utilising it all most effectively.

The construction of the Canadian Pacific Railway which began in 1881 not only marked the greatest enterprise ever undertaken by a nation of 4,000,000 people but it also set the seal of national approval upon the future of the new west. In that year the entire wheat crop of the prairies is given as 1,153,328 bushels. The population of Manitoba was 62,000, while another 56,000 people were scattered over the plains to the west, and beyond the mountains were 49,000 in the Province of British Columbia organised ten years previously.

Although the construction of the Canadian Pacific Railway exceeded all speed records yet settlers poured in by thousands in advance of the railway. Many men still living traversed the prairie country on foot before the advent of the railways. In the House of Commons at Ottawa are five members still living upon the homesteads upon which they settled before the first locomotive of the Canadian Pacific Railway had crossed the prairies. When the first train from eastern Canada reached Winnipeg the little trading post had become comparatively a thriving metropolis, with every conceivable description of building tack-hammered together for the shelter of the thronging immigrants. They were even enjoying a real estate "boom", one of the periodic pastimes of the country.

When Lord Strathcona in 1885 drove the golden spike which completed the Canadian Pacific Railway, it opened up the great national highway from the Atlantic to the Pacific. By this time the prairie schooner had become a national institution as families trekked across the prairies seeking what seemed the ideal place for a homestead. There was no restriction and no general policy followed in the settlement of the prairies. A population of 200,000 people was allowed

to scatter over an area as great as that occupied by 100,000,000 people in eastern Europe. Then and there was laid the foundation of one of the great economic problems of the country, namely the cost of maintaining the facilities of civilisation for a sparse population over a great area. The great desire of the settlers was to get land. Probably the great majority did not intend the country to be their permanent home but looked forward to acquiring a competency and the enjoyment of their later years in their native land.

The world has usually regarded the wheat crop of the prairie provinces as a fair index of the development of the country. Consequently the following figures showing the growth of the wheat harvest from 1881 to the present time will be of interest:

Production of Wheat in the Prairie Provinces

1881	1,153,328
1891	17,884,629
1901	23,456,985
1905	82,461,627
1906	110,586,824
1911	208,366,000
1912	204,280,000
1913	209,262,000
1914	140,958,000
1915	342,948,000
1916	242,314,000
1917	211,953,000
1918	164,436,100
1919	165,544,300
1920	234,138,300
1921	280,098,000
1922	375,194,000
1923 (est.)	446,570,000

There are no official figures of interprovincial movements of population but a large proportion of the people in western Canada to-day came from Ontario and the maritime provinces and a smaller number from Quebec. From outside of Canada the largest contribution has been from the United Kingdom with the United States a close second as the table on page 38 will indicate, as showing the total Canadian immigration, the greater part of which made the western provinces its destination.

The census of 1921 gave Manitoba a population of 610,118, Saskatchewan 757,510, Alberta 588,545, and British Columbia 524,582; and the latest figures give the railway mileage for Manitoba as 4,403, Saskatchewan 6,220, Alberta 4,474, and British Columbia 4,325. More than one-half the total railway mileage of Canada is west of the great lakes. Never has such a small population been served with such railway facilities and yet such has been the scattered nature of the settlement that many localities are without necessary transportation.

NUMBER OF IMMIGRANT ARRIVALS IN CANADA 1897-1922

Fiscal year	United Kingdom	United States	Other Countries	Total
1897	11,383	2,412	7,921	21,716
1898	11,173	9,119	11,608	31,900
1899	10,660	11,945	21,938	44,543
1900	5,141	8,543	10,211	23,895
1901	11,810	17,987	19,352	49,149
1902	17,259	26,388	23,732	67,379
1903	41,792	49,473	37,099	128,364
1904	50,374	45,171	34,786	130,331
1905	65,359	43,543	37,364	146,266
1906	86,796	57,796	44,472	189,064
1907	55,791	34,659	34,217	124,667
1908	120,182	58,312	83,975	262,469
1909	52,901	59,832	34,175	146,908
1910	59,790	103,798	45,206	208,794
1911	123,013	121,451	66,620	311,084
1912	138,121	133,710	82,406	354,237
1913	150,542	139,009	112,881	402,432
1914	142,622	107,530	134,726	384,878
1915	43,276	59,779	41,734	144,789
1916	8,664	36,937	2,936	48,537
1917	8,282	61,389	5,703	75,374
1918	3,178	71,314	4,582	79,074
1919	9,914	40,715	7,073	57,702
1920	59,603	49,656	8,077	117,336
1921	74,262	48,059	26,156	148,477
1922	39,020	29,345	21,634	89,999
Total				3,789,364

Thus far of the past and the present. What of the future? Here is an enormous country only partially settled possessing the facilities of civilisation practically sufficient for twice the population. The fertility of the soil on the whole has been but slightly depleted and yet agriculture is suffering severely from the post-war depression which in all countries struck agriculture first and bears upon it more heavily than upon other industries. The chaotic condition of Europe and its consequent lack of purchasing power is the chief cause of the agricultural depression. The bulk of agricultural production in western Canada is of exportable products. Nowhere in the world is the food production per capita so great and the European market is the main outlet, particularly since the American markets have been curtailed by hostile tariffs.

But a careful survey of agricultural conditions in the United States, Great Britain, Australia, and other large producing countries indicates that agriculture is on the whole suffering less in western Canada than in these other lands. Furthermore agriculture is undergoing great changes in this part of Canada. Although wheat is the great product and will remain so for many years yet diversification is being more widely practised year by year. Even with a normal crop, wheat is but one-third of the total production of the farms of Manitoba at the present time and the percentage is being steadily reduced.

Dairying, poultry raising, cattle feeding, and other lines of "mixed farming" have been advancing rapidly.

Systematic tree planting is steadily transforming the face of the bare prairie country giving protection from the drying winds of summer and shelter from the chilly blasts of winter. Over 70,000,000 trees have been distributed free to farmers for supervised planting in the past twenty years by the Dominion government. Year by year the planting of trees increases adding greatly to the homelike appearance of the country. In the shelter of these plantations it has been found that a wide range of cultivated fruit can be grown successfully, and in a few years crab apples, plums, strawberries, raspberries, currants, and gooseberries will be common in farm gardens. Indeed some of the smaller fruits will shortly become commercially profitable. Even grapes and melons are grown on the prairies. Bee-keeping is extremely profitable owing to the long hours of summer sunshine and the exceptional nectar secretion of prairie flowers. It is to-day the opinion of all observers that the agricultural possibilities of this great country are but partially known and that its future development will be as phenomenal as its past.

Millions of acres of excellent land are still lying idle upon the prairies reasonably close to railways, schools, and churches, waiting for the hand of the settler. The general depression has affected the value of farm lands and to-day farms either improved or unimproved are purchasable at very low prices and frequently on long terms and at reasonable rates of interest. Thousands of farmers with large holdings would sell a part of their land as they are turning from exclusive wheat growing and find the economic unit smaller than that required for wheat. There will be no shortage of land for agricultural purposes in this country for another generation. The development of the Vancouver route for wheat is now a reality and will afford great advantage to Alberta and western Saskatchewan. The completion of the Hudson Bay railway and the opening of that northern route to Europe as well as the opening of the St. Lawrence to ocean ships are among the certainties of the future as the production of the country demands further outlets and relief from congestion on existing lines.

The prairies and British Columbia can accommodate millions of additional people comfortably. There is opportunity here for a considerable portion of the surplus population of the United Kingdom, provided those are selected who have a reasonable likelihood of being able to maintain themselves. It is no country for weaklings nor for those who feel that society owes them a living. There is opportunity for the surplus of trained farmers from many of the countries of northern Europe whose fellow countrymen have "made good" in large numbers

in the west. All these peoples are now moving towards western Canada again as before the war. American farmers are again beginning to look northward towards cheaper land and the indications are that there will be a heavy influx of settlers from the United States in the near future.

In the early days the lure of the prairies was much like that of the goldfields. To-day the opportunities of this country beckon to the genuine homeseeker. It is no Eldorado but a country where labour will reward the husbandman and where settlers may become established with very small capital investment. Law and order are firmly established and the institutions of civilisation are well provided. Never in history has a country with such facilities and such undeveloped resources invited the world to share in its privileges and its responsibilities. When the opportunity is realised the response will be great.

RACE IN CANADA

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The ideal of the Melting-pot is one which has never commended itself, for any long time together, to Canadian opinion; and despite the very large immigration which has occurred at certain periods in the history of this country, the prevailing stocks are still Anglo-Saxon and French, whose continued supremacy, at least for a considerable time to come, is likely to be maintained.

Since the results of the census of 1921 are still incomplete, it is not yet possible to make a complete and up-to-date analysis of racial composition. The problem is further complicated, first by the fact that boundary revisions in Europe and the creation of the Succession States have altered somewhat the basis of racial classification in Canada; secondly, because among the people of European origin there may be present, since the war, the strongest of motives for the mis-statement of racial origin. "In 1911" says a recent bulletin of the census, "a great many people described themselves as Germans, while in the last census the same people classified themselves as Dutch."

Broadly speaking, however, it may be said that in 1921 about 83 per cent. of the people were of British or French stock. The British constituted slightly more than 55 per cent. of the whole population: the French slightly less than 28 per cent. The relative increase of these two races during the last ten years was as seven is to three. The French are in fact a gradually dwindling minority, but the change is so slow as scarcely to be perceptible; and the compactness of the French settlements, alike in Quebec, the maritime provinces, Ontario, and the west, has given to the French tradition, wherever it is rooted, a remarkable stability.

It is to be hoped that within a short time the salient facts of the 1921 census will be presented graphically in a new official atlas of Canada. For the present, however, the most recent maps which illustrate racial distribution are based on the census of 1911. They are to be found in the Atlas of Canada (1915) issued by the Department of the Interior.

Racial Distribution by Provinces.—A picture is presented in Plates 23-26 of the Atlas of Canada which may be summarised as follows:

The Maritime Provinces—Nova Scotia divides about equally between the Scots and English. East of Halifax (including Cape Breton island) the predominant strain is Scottish. West of Halifax it is English, except for (*a*) the French-speaking fishermen north and south of Yarmouth—descendants, for the most part, of the settlers of Acadia: and (*b*) five Teutonic settlements, abutting on the Atlantic seaboard, of which the most important is in the neighbourhood of Lunenburg. Prince Edward Island is predominantly Scottish, with scattered English, French, and Irish settlements; New Brunswick is a patchwork of English and Irish, with three scattered Scottish groups, and a considerable French settlement from Northumberland strait to Chaleur bay.

Quebec—Four-fifths of the population of Quebec is French-speaking and of French origin. Only in Montreal, in the neighbourhood of the United States border, in Argenteuil, and along the Ottawa river do we find distinct and important communities of English-speaking people. Nevertheless, there is a strong admixture of Scots blood here and there, in the villages of New France. Greece is not the only country which has led captive her rude conquerors; and it is not uncommon, in districts where the disbanded Highlanders of Wolfe were settled, to find Macdonalds and Macphersons who cannot make themselves understood except in French, but whose aptitude for accumulation makes them conspicuous even among the thrifty *habitants*.

Ontario—There are two densely populated sections of Ontario, each of which is triangular in shape. The former, which is bounded, broadly speaking, by lines joining Kingston and Pembroke and Cornwall, is predominantly Irish in character, despite the presence of strong Scots settlements in Glengarry and around Arnprior, and a Teutonic strain in the district that lies between Pembroke and the Madawaska river. The latter, the district west of Kingston and south of Georgian bay, shows more variety. The settlers along the shores of Lakes Erie and Ontario were almost invariably English; witness the Yorkshire names so frequent in the neighbourhood of Toronto (Muddy York), such as Don, Humber, Burlington, Whitby, Pickering, Bradford, Cottingham, Richmond; and the close parallelism, in nomenclature at least, between London on Thames, in the county of Middlesex, Ontario, and the City of Cockaigne. But Hamilton derives its character from Scottish settlers; Essex county, washed by the Detroit river, was originally peopled by Frenchmen; and for many miles round Kitchener the population is predominantly German in origin.

North of the Georgian bay, along the waterways between Pembroke and Sault Ste. Marie, a large and increasing migration from the

neighbouring province of Quebec has given the countryside a character increasingly French. Nevertheless, alike in the lumber camps and mines of northern Ontario, there is a great diversity of race and language: as is only to be expected in communities of recent and very rapid growth.

The Prairie Provinces—What has been said above of northern Ontario applies with still more force to the district which lies between the Great Lakes and the Rockies; whose population increased thirteen-fold between 1891 and 1921, from 150,000 to 1,950,000. The mixture of races which resulted is far too complex to be described briefly.

The best known of the immigrant settlers are, perhaps, those who have created self-contained communities; chief among them the Mennonites, who came from the United States to southern Manitoba in 1876, and the Doukhobors, who were brought from Batoum in 1899, and were established in villages to the north of Yorkton in Saskatchewan. Less conspicuous racial units, like the prosperous Icelandic population on the shores of Lake Winnipeg, because they do not embody religious or social ideas of an unusual character, resist assimilation less strongly. But wherever—as, for instance, in the Galician farming population north of Saskatoon—a wide stretch of land has been "taken up" mainly by foreign immigrants of the same race and language, the state is faced with a task which, if it was difficult before the war, is harder still to-day.

Elsewhere in the west, racial maps of the rural districts (rare fruit of very patient labour) form a patchwork quilt, of quarter-sections for the most part, in which English and Scots and Irish, Scandinavians and Germans, Galicians and Russians are inextricably mingled, though some one race is as a rule predominant in every township.

British Columbia—Though the Chinese are to be found in every large Canadian city, the problem of Asiatic immigration is for obvious reasons most acute on the Pacific coast, where the oriental has been conspicuously successful both as a truck farmer and in salmon fishing. Here are to be found more than twenty-three thousand Chinese, and fifteen thousand Japanese, as well as some nine hundred Hindus. Altogether, nearly 70 per cent. of the Asiatics in Canada live in British Columbia, where they constitute between 7 and 8 per cent. of the total population.

On the other hand, the races of continental Europe are less in evidence here than on the prairie. The proportion of the total population which is of Anglo-Saxon origin is, according to the census of 1921: in Saskatchewan 53 per cent.; in Manitoba 58 per cent.; in Alberta 60 per cent.; and in British Columbia 74 per cent.

Racial Elements of the Cities.—It will be seen in the table given below that the population of the chief western cities contains in every case a proportion of Anglo-Saxons considerably larger than is to be found in the surrounding country. The cities in which the British element is most marked are, in this order: Halifax, Toronto, Calgary, and Hamilton.

POPULATION: ORIGIN BY CITIES: 1921

City	Total Population	Of British Origin	Per cent. British	Of French Origin	Per cent. French
Halifax......	58,372	50,409	86	3,000	5
Quebec......	95,193	8,635	9	85,350	90
Montreal....	618,506	148,630	24	390,168	63
Ottawa......	107,843	68,215	63	30,442	28
Toronto.....	521,893	445,230	85	8,340	2
Hamilton....	114,151	95,097	83	1,956	2
Winnipeg....	179,087	120,569	67	3,944	2
Edmonton...	58,821	45,644	78	2,707	5
Calgary.....	63,305	52,949	84	1,408	2
Vancouver...	117,217	93,609	80	2,252	2

Indians.—British Columbia contains a larger number of Indians than any other province, excepting Ontario. In the country as a whole, the decline in the Indian population appears, for the time at least, to have been arrested. The number of Indians in Canada, which diminished between 1901 and 1911, from 128,000 to 105,000, was returned as 110,600 in the census of 1921. The great majority live within the Indian Reserves, of which perhaps the most easily accessible is in Ontario, to the south of Brantford.

Immigration.—Despite a considerable admixture of new blood in recent years, by contrast with the inhabitants of the United States, the people of Canada have remained comparatively homogeneous. To what may this difference be attributed? It will be sufficient, perhaps, in this place, to suggest two influences, whose importance is outstanding.

First, although the building of the Canadian Pacific Railway and the opening of the west for settlement synchronised fairly closely with the new immigration from south-eastern and central Europe, the period of most rapid development did not begin in Canada till the dawn of the twentieth century. From 1870 till 1900 the population of the United States was increasing much more rapidly than that of Canada—nearly twice as fast. The Dominion was relatively stagnant. It is only within the last generation that the rate of growth in this country has been the faster; when an extraordinary combination of circumstances in the world, outside of as well as in Canada, went far to justify the grandiloquent challenge of Sir Wilfred Laurier.

During the lean years in the later part of the nineteenth century the tide of Latin and Jewish and Slavonic immigration flowed with

overwhelming strength towards New York; and the very poverty which Canadians united to deplore (though it prompted a large southward movement of the native-born, which has sometimes dwindled since then, but never altogether ceased) tended at the same time to preserve the integrity and leave unchallenged the predominance of the French- and English-speaking peoples in this country.

Second, even more important, we may surmise, was the position of Canada within the British Commonwealth of Nations. Far more, indeed, than trade, migration tends to "follow the flag." The fact that in crossing the Atlantic the British emigrant need not change his allegiance is an influence in the choice of his destination. The importance of this influence, if only very roughly, can be measured.

In the days of her heaviest immigration, immediately before the war, Canada was receiving annually from 200,000 to 400,000 newcomers. She had at the time a resident population equal to not more than one-twelfth of the American. Her wealth, it was supposed, was in a less proportion.

If we may judge by these criteria the relative economic attractions of the two countries, Canada should have received about 20,000 British immigrants each year. Actually, between 1908 and 1912, the number reached an annual average of 100,000. She secured not 8 per cent. but 48 per cent. of the joint supply. In the United States, the proportion of British to total immigration was almost exactly one-eighth; in the Dominion, it was a little more than three-eighths. Though the volume of alien immigration into Canada was great and increasing, it was offset largely by the sentimental claim, to which so many from the British Isles responded.

That claim will persist, it is reasonable to suppose, as long as the British Empire lasts; but it is by no means certain that in the future we can count on it as strongly, now that the traditional American immigration policy has been reversed, to stabilise the racial development of Canada.

PROGRESS OF SOLDIER SETTLEMENT IN CANADA

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Of the men of the Canadian Expeditionary Force who went overseas for active service in the Great War eight per cent. have been established on the land under the aegis of the Soldier Settlement Board of Canada. This figure is arrived at in this way: Canada's contribution in combatant material numbered 590,570 men, of whom 418,031 were sent overseas, and approximately 350,000 saw service in France. Deducting 62,496 officers and other ranks who were killed or who died on active service, there remain 355,535 of all ranks who returned to Canada. Of this number 28,984 have taken advantage of the government's land settlement plan, being a percentage of 8.1 of the men who returned from the war. Of course many who came back were so broken in health that they were debarred from taking advantage of the land settlement plan, as only the physically fit were eligible; also many returned to their old employment, and it was a greatly restricted number to which the " Back to the Land" movement appealed.

The original plan, proposed in 1917, was crystallised into legislation in August of that year. This legislation created a Board of three commissioners, reserved for soldier settlement all Dominion lands lying close to the railways, and authorised the Board to make advances to veterans up to $2,500 for agricultural purposes. But with the conclusion of hostilities in November, 1918, and the return to Canada of many thousands who desired to take advantage of the government's proposals and go on the land, the powers of the Board were widened. It was authorised to purchase land for soldier settlement in any province and to make advances up to a maximum of $7,500. Two purposes were in view: the promotion of agricultural development and the re-establishment of many men of the Overseas army who might otherwise have chosen to stay in the large centres of population, thus adding to the difficulties of the problem of unemployment.

The figures which will be used in describing the progress of soldier settlement work are of the 31st March, 1923, the end of the fiscal year. On that date 85 per cent. of the settlers with loans had shown varying degrees of progress in their work. Under a system of visitation by field supervisors, a close watch is kept and reports are made from time

to time on every settler's prospects. In passing an applicant as qualified to receive the benefits of the Act, every care is taken to protect him against unwisely embarking upon a project for which he would prove to be unsuited. Two considerations enter: the man must be qualified to farm and the land must be suitable for the kind of farming that he undertakes. The Soldier Settlement Board, however, does not turn from the door every man who lacks farming experience. If he is physically and temperamentally fit, is honest and sincere, and if his wife will cheerfully acquiesce in his decision, the man is given a chance to qualify. He is advised to seek employment with a successful farmer. Up to March 31st, 66,116 applications for qualification were received; 46,943 of the applicants were qualified; 9,257 were recommended to obtain further farming experience; 16,603 were disqualified; 3,870 applicants completed or discontinued training. Of the applicants who have gained experience by working on farms 1,169 were qualified and 2,301 were disqualified. If after the period of probation the Board thinks the applicant is capable of undertaking the responsibility of farm ownership and management, it will grant him qualification.

When the man is on his own farm the supervising officer reports on his progress until such time as he has demonstrated that he is capable of carrying on alone and that the Board's security in the land which he is farming is safe. The supervisor advises against the purchase of unnecessary machinery and stock, suggests improved methods of tillage and cultivation. He makes recommendations for further improvement and equipment loans. It may be that the settler sometimes resents the "paternal" interest of the Board's representative, but if he is sincere and straightforward in his dealings with the Board, he will gladly accept the recommendations of the supervisor. Within the past year approximately 5,000 men have been stricken from the supervisors' rolls; that is, they have shown such progress as to warrant the assumption that they can carry on without the guidance of the Board's supervisors.

In another way assistance is brought to the settler by the Home Branch officers. Many of the wives of the settlers are from the old land—English, Scotch, Irish, French, and Belgian—women who were brought up in crowded centres of population and suddenly set down on farms far from neighbours and friends. It is not surprising that many were almost overwhelmed with the loneliness and dreariness of the new life. It is essential, if the settler is to succeed in his undertaking, that his wife must co-operate. The Home Branch was organised with the aim of dissipating the loneliness of these women and helping them to forget their isolation. It assists the settler's wife in organising

her household so that she may be a help rather than a hindrance to her husband. It distributes literature on farm and home topics, and gives instruction in the most essential of the domestic arts. It affords relief to those who suffered from mischance in no way due to the settler's indifference and incapacity. It is believed that many failures have been averted by the splendid co-operation of the women who constitute this branch of the service.

A few figures will show the prodigious volume of the work that has been carried on by the Soldier Settlement Board. Of the 28,984 men (war veterans) who have taken up land, 22,626 have been granted loans amounting to the sum of $94,733,547.59 for the purchase of land, for improvements, and for stock and machinery. Other 6,358 veterans have been settled on free Dominion lands without financial assistance, although they may later take advantage of the offer of advances for the erection of buildings and for equipment. Since the beginning of operations, the sum of $15,243,167.28 has been returned to the treasury, of which $5,463,242.09 was in initial payments on land purchase, the balance in repayments on principal and interest.

The area occupied by soldier settlers, including purchased and free lands, aggregates 5,487,984 acres, and an area of about 600,000 acres of this has been broken by soldier settlers. The largest area of soldier lands is in Alberta, where 2,019,518 acres have been settled. Saskatchewan has 1,829,227 and Manitoba 986,007. Over two million and a half acres of free Dominion lands have been taken up by 9,783 returned men, and 6,358 have not asked for financial assistance. The Soldier Settlement Board secured a reversion to the Crown of large areas of agricultural lands which had been alienated for grazing leases and other purposes. Reserves were purchased from the Indians; forest reserves were turned over to the Board for agricultural development; large numbers of ex-service men have been established where hitherto there have only been waste spaces. It will take quite a number of years to bring these new lands up to a state of full cultivation. These free land farms average about 240 acres, and settlers are adding to their area of broken and cultivated land at the rate of nearly ten acres a year.

It is not surprising that in a settlement project of such large dimensions a few have not measured up to expectations. In the case of slightly more than 14 per cent. of the settlers who have been granted loans the Board has been compelled to repossess and sell the farms, either to other returned soldiers or to civilian settlers. A number of the failures have been due to death, ill-health, or the recurrence of a war disability, circumstances over which the settler had no control. Other causes may be cited as: wife did not like farm work; wife separated

from husband; settler went into other business; settler dishonest in dealings with the Board; non-residence; ill-health of wife or members of the family; infelicity; depression and worry; crop failures, due to drought, blight, etc.; lack of sincerity on the part of a settler in his undertaking; lack of experience; and unsuitable land. Undoubtedly there were qualified many settlers who should have been denied the privileges of the Act, but when demobilisation was at its height there was a great rush of applicants and facilities for testing them were not the best. The Board has learned the lesson of the experience of the earlier days and there has been a very small percentage of failures among those who have come forward in the last two or three years. In those cases of failure where the land has been resold to other returned men or to civilian settlers, a substantial profit has been realised from the sale of the land itself. There has been a loss on stock and machinery, but the increase in the price of the land has more than offset such loss. Taking 1,301 parcels of land which have been sold there has been a profit of $496,613.46, which illustrates the care and wisdom shown in the selection of these farms.

During the parliamentary session of 1922, the Committee on Soldiers' Affairs probed deeply into the whole question of the cost of farms to settlers. It was urged by the Alliance of Returned Soldier Bodies that, owing to the agricultural depression ensuing in 1921, there should be a revaluation of soldiers' farms. The committee in its report to Parliament, while taking the view that some relief was necessary, did not favour revaluation, but instead recommended an exemption from interest for settlers who had gone on the land prior to 1921. The committee found that "The Soldier Settlement Board was exceedingly efficient in supplying stock and equipment, and in fact the land itself to the settlers, at exceedingly moderate figures. In fact, the lands so supplied, certain of which have fallen back into the hands of the Board, have been sold at a greater price than was paid by the Board therefor". The committee went on to say that "evidence had been submitted showing that the average price paid by the Board for the soldiers' livestock, although moderate at the time of purchase would, in view of the present prevailing prices, be higher than would be paid for the same livestock and equipment now". And so the earlier settlers were granted relief from the payment of interest from two to four years, according to the time at which they went on the land.

With reference to the purchase of stock and equipment, the prices of which, as the committee stated, were exceedingly moderate at the time of purchase, the Board has figures to show that substantial amounts were saved to the settlers by the system of purchasing adopted. In stock and equipment the saving to the 31st March has been

$1,093,090.80. This was effected by securing from the agricultural implement dealers special rates for settlers taking up land under the Board. In land purchase the amount saved was $4,244,746.40—that is, the difference between the price asked by the vendor and the price actually paid. Within recent months a case came to the notice of the Board where a farm was secured for a settler at a reduction of $1,000.00. Undoubtedly it was these favourable terms which the Board was able to secure that have been a considerable factor in influencing many men to stay with their propositions, despite the bad turn that agricultural affairs generally have taken in the last two or three years.

With regard to the repayments that have been made by the settlers, it is interesting to note that 583 men have completely discharged their financial obligations to the Board. Of this number 312 have continued to operate their farms; the others have sold out completely and have gone into other vocations.

In the session of 1922, Parliament adopted the recommendations of Mr. Marler's committee, and passed two important amendments to the Act. One was as stated: the exemption from interest for certain periods; the other was to make the payments for stock and equipment run over 25 years in place of four to six years, as provided by the Act. During the past repayment season there was due on principal and interest a total of $2,092,994.46. On the 31st March 43 per cent. had been paid, in addition to $336,238.69 which was not due. Payments continued to come in satisfactorily, and at the end of July the percentage of moneys received amounted to 62.8. The leading province with respect to repayments was Prince Edward Island, where the settlers had paid 128 per cent. of the amount actually due. Ontario paid 112 per cent.

What is the future of soldier settlement? It would be impossible, of course, to answer that question, but those who have studied the problem and watched the progress of soldier settlers are convinced that a very large proportion of them will ultimately succeed. The former Prime Minister of Manitoba, Mr. Norris, stated to the writer in the early days of the scheme that if 50 per cent. came through and remained on their farms, the scheme would prove to be of great benefit to the Dominion. It does not seem unreasonable to expect that 75 per cent. will remain on their farms and pay back their loans to the government. The weak ones who were accepted during the greatest rush of applicants have been pretty well eliminated. There will be others who will fail, not because they have not tried, but because of adverse circumstances which they could not control. A succession of crop failures in certain districts will undoubtedly place many soldier settlers in a

precarious condition. Some have fallen for this reason; others have experienced successive losses, but have battled through with the determination to win out. The fighting spirit of these settlers is commented on by the English writer, Mr. Noel Inchcape, who gives some illustrations in the "Yorkshire Observer" of settlers who have won the victory. For example: "Take this for victory. Two or three years ago in British Columbia there were strips of bush so dense that nowhere was there space for a single log cabin or even a tent. Nature had run riot. To-day men who had the pluck to settle there have cleared holdings ranging in size from three to ten acres, and have not only their cabins but substantial prospects of real homesteads and of expanding prosperity. They know out there how to solve the housing problem with their own strong right arms. So far from bemoaning the part they have had to play in answering the challenge of nature, they are thankful for what they feel is life made spacious." In an interesting and illuminating address before the Canadian Club of Ottawa, Professor C. R. Fay, M.A., D.Sc., Fellow Lecturer in Economics in Christ's College, Cambridge,[1] told of his investigations during a period of four months of the progress of soldier settlers in the west. He summed up his conclusions in this way: "In the main they are holding their own. They are digging in under a devastating bombardment of less than pre-war prices for their products and double pre-war costs. Their morale is superb. The technique of the soldier settlers is above the average of those civilians who have settled for a similar length of time."

Soldier settlement is under the direction of a Board of three members, who are responsible to the Minister of the Interior. They are: Major John Barnett, Chairman; Major E. J. Ashton, D.S.O., and Mr. Samuel Maber. In an address before the Rotary Club of Ottawa, the chairman pictured the returned soldier on the land as a coloniser and pioneer who is still doing a national service, equal in value in the present economic crisis to the work he did in war days. He pictured a number of settlers of different types who had met with adverse circumstances, but had managed largely through their own determined efforts, assisted by the Board's supervision staff, to secure a permanent footing. One illustration will suffice here. It relates to an Irishman who purchased a half-section through the Board in Manitoba in 1920. The farm was composed of bush and prairie. The settler was a steady plodder and it was not long before he had built a house, stable, and granary. Securing two horses through the Board he privately picked up some old implements and started in to transform his unimproved land into a comfortable farm home. The first year he broke 60 acres. As he did not have a crop that season he worked out during his spare time, sometimes for a few dollars and often for a piece of machinery or even

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a few fowl. In 1921 he seeded 45 acres to wheat and 15 to oats, breaking five acres which he seeded for green feed. His crop was 1,100 bushels of wheat, 500 bushels of oats, and 15 loads of green feed. Besides this he broke 35 acres of new land. In 1922 he harvested 3,000 bushels of wheat and 2,000 bushels of oats. He also broke 25 acres. To-day this settler has on what was an unimproved farm in 1920: 125 acres cultivated, frame house, frame stable, four granaries, a good well, a full line of implements, five horses, two cows, two calves, one hundred fowl, five pigs, and a sow.

THE GOVERNMENT OF THE CANADIAN FEDERATION

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The Dominion of Canada is a federation of nine provinces working under a series of Acts known as the British North America Acts, 1867-1915, and under the great landmarks of British constitutional developments, except in so far as modified by the statute law of Canada or its provinces. These facts, however, must from one important angle, be clearly understood. The federal and provincial legislatures are in no sense delegations or agents. On the one hand, the federal government is not a delegation from the British parliament, and on the other, the provincial governments are delegations neither from the federal parliament of Canada nor from the British parliament. Every legislature in Canada, working within its defined constitutional ambit, is a sovereign legislature with as absolute authority over its territory and the subject matters of its legislative scope as the British legislature itself.

In the most interesting aspect of federalism—the distribution of legislative power—there are certain features requiring notice. Firstly, there is no reserve of legislative power in Canada, vested, as in the United States of America, in the people. All spheres of legislative action dealing with the internal affairs of Canada are covered by the constitutional distribution of powers among the various legislatures. Every matter of Canadian legislative competence is provided for, whether in the federal or provincial legislatures. Secondly, the central government is not one of defined powers as in the United States and Australia. To the Canadian provinces are granted sixteen enumerated and exclusive subjects, and to the federation belongs the residuary power. However, in order to make that residuary power clearer, and not to restrict its general nature, the federal legislature is given power over twenty-nine enumerated subjects "notwithstanding anything in the Act." That is to say: the provinces possess certain defined and exclusive powers, and the Dominion possesses the general residuum; but the exclusive powers of the provinces may be modified or curtailed if judicial decisions draw any of them into the ambit of the enumerated subjects granted to the federation. Finally in this connexion, the

provinces possess a special exclusive power over education, while over immigration and agriculture concurrent legislative authority exists. All laws are enacted by the King in parliament. A legal right of disallowance resides in the British Cabinet over federal legislation; but amicable workings make it of little importance. Indeed it is a matter where custom has repealed law, and no federal government would be the least likely to tolerate its exercise for one moment. The Dominion government posseses a similar veto in provincial legislation. There has been much friction in this connexion in the past, and difficulties are far from being resolved. The subject, however, is quite domestic and is, in addition, too highly technical for an article of this nature.

Executive authority in both the federal and provincial areas is vested in the Crown, represented in the former by a governor-general and in the latter by lieutenant-governors. A convention has grown up in the relation to the appointment of a governor-general. No one is sent to Canada without consultation with and approval by the Canadian government. He acts uniformly on the advice of his ministers. It is true that in law he is not a viceroy protected from suit for his official acts; but the developments of "dominion status" have once again nullified legal rights. For his own protection it would be well if the law were brought into line with the constitutional practice. He has ceased to be the sole and normal channel of communication with the British Cabinet, as the Canadian Prime Minister can, at his own discretion, correspond directly with the Prime Minister of Great Britain. In fact, the Governor-general is a president nominated by the Canadian government, a visible link between Canada and Great Britain representing the King, not the British government nor the Colonial Office. The King is represented for the purposes of provincial government by a lieutenant-governor in each province. He is appointed by the Governor-general in Council, but he exercises all the functions of the Crown necessary for provincial government and is no mere creature of the Federal Executive. His position and constitutional functions cannot be altered by any Act, federal or provincial.

The executive government of the Dominion is carried on by a cabinet of ministers selected from the political party in power, and appointed by the Governor-general on the recommendation of the Prime Minister. Ministers in charge of departments are paid a salary in addition to that as members of the legislature, but a minister without portfolio receives no additional remuneration. As soon as a cabinet has taken the oaths of office they act with the Governor-general as executive government of Canada. They carry out functions which they have inherited from British precedents in organisation and in procedure. The relations between them and the Governor-general are

now fairly clear. He does not attend cabinet meetings, but he is entitled to receive the full confidence of the ministry when they ask him to act in any official capacity. If confidence does not exist, he can technically dismiss them—dismissal is unknown in federal history—and doubtless he has the constitutional right to refuse a dissolution. Ordinary common sense, however, prevails. The constitutional convention of responsible government and the necessity for keeping the Crown out of party politics are more than a balance for the rigidity of constitutional law.

In the provinces, the executives are modelled on the British type and follow the lines of cabinet administration. The functions of the provincial cabinets, the theories and conventions governing them, and the duties of the lieutenant-governors are so similar to those in the federal sphere as not to call for special treatment. It is only necessary to say that if any one wishes to study the cabinet system of Great Britain in microcosm he can do it with ease in a Canadian province.

The federal parliament is bi-cameral consisting of a Senate and a House of Commons with co-ordinate powers. The former is a nominated house and members are appointed by the Governor-general on the advice of his ministers and hold office for life. The Senate does not represent the constituent provinces as in the United States and Australia, but appointments are made in such a way as to represent groups of provinces—Quebec and Ontario have twenty-four members each; the maritime provinces and the western provinces, twenty-four for each group—ninety-six members in all. In case of deadlock the Governor-general can be advised to appoint from six to eight additional members.

The number of members in the House of Commons varies according to a redistribution after every decennial census which is governed by a statutory constitutional principle. The representation of Quebec is fixed at sixty-five members and each province is assigned every ten years such a number of members as will bear the same proportion to its population as the number sixty-five bears to the population of the province of Quebec. Any adult British subject can become a member, subject to regulations similar to those which govern disqualifications in Great Britain. All members receive an indemnity for their services and enjoy certain privileges in travelling and in postal facilities. The leader of His Majesty's opposition is paid a statutory salary in addition to his sessional indemnity.

The federal electoral constituencies are determined by the federal parliament, which has also power to define the qualifications, etc., for the federal franchise. Domestic politics have, however, modified procedure in the latter sphere. Under federal legistation the provincial

voters' lists are now used for the federal elections. All British subjects by birth or naturalisation, irrespective of sex, of full age, and not being Indians ordinarily resident on an Indian reservation, are qualified to vote. They must have resided in Canada twelve months, and in the electoral division where they seek to vote two months immediately preceding the issue of the writ of election.

Every House of Commons can continue for five years unless previously dissolved by the Governor-general acting on ministerial advice. The arrangements for a new election are in the hands of the chief electoral officer, who acts in each constituency through a returning officer. In addition to the general oversight of the election, the latter is responsible for seeing that candidates have consented to nomination and have made deposits of two hundred dollars each, which are returned to the successful candidates but forfeited by opponents unless they obtain a number of votes equal to one-half the number of votes polled in favour of the candidate elected. All official election expenses are a charge on the Dominion.

In the provinces, only two of the provincial legislatures are bicameral—Nova Scotia and Quebec—and members of these upper houses or legislative councils are appointed for life by the respective Lieutenant-governor in Council. In neither province is there any provision for deadlock or for the adjustment of differences between the two chambers.

It is unnecessary to describe in detail the composition and procedure connected with the nine provincial houses of assembly. In most provinces adult suffrage prevails. In Nova Scotia and Quebec there are small property, income, or rental qualifications. The disqualifications for voters are analogous to those in the federal area—all being founded on British experience—but in some of the western provinces there are additional disqualifications founded on race and illiteracy. In all provinces members are paid and a provincial legislature has the exclusive power to change its constitution provided that it does not interfere with the office of Lieutenant-governor.

The privileges of the Canadian legislatures are now clear. Those of the federal parliament can be brought, from time to time, by federal statute, into line with contemporary practice in the British parliament. The provinces have full power to define their parliamentary privileges and have done so under provincial legislation which is constitutionally beyond dispute.

Canada does not possess a federal system of courts such as exists in the United States of America, although such a system could be constitutionally created. The provinces have exclusive power to constitute, to organise, and to maintain provincial courts of both

civil and criminal jurisdiction. The provincial legislatures can regulate the procedure in civil matters. The Dominion parliament may impose new duties upon provincial courts and may give them new power in the matter of subjects not assigned exclusively to the provinces. The appointment of the higher judges lies with the Governor-general in Council. The provincial courts deal with all matters of litigation under federal and provincial law. They hear election petitions and have jurisdiction in cases of controverted elections. They also have the duty of giving opinions on the constitutionality of Acts for the guidance of the provincial cabinets. The tenure of all judicial office is regulated by law, and judicial officers hold on good behaviour, subject to removal governed by statutory rules.

There are only two federal courts in Canada—the Supreme Court and the Court of Exchequer and Admiralty. The latter deals with patents and such matters, and with petitions of right in the federal area. The former hears cases on appeal from the provincial high courts under conditions laid down by law. Appeals go by leave or of right from the supreme courts of the provinces and by leave from the Supreme Court of Canada to the Judicial Committee of the Privy Council.

Finally, Canada has no legal power to dissolve its union with the British Commonwealth or to change its constitution. Possessing a right to legislate for "the peace, order, and good government" of Canada alone, and that under a British Act, it could not pass an Act withdrawing the Dominion from the Commonwealth, for that would be a legislative act of undoubted unconstitutionality and one to which the Crown could not legally assent. Again, owing to the historical circumstances out of which the federation grew, constitutional changes in the written constitution are outside Canadian legislative competency. The British Government provides them automatically through British legislation upon the request of Canada. Theoretically, the limitation is undoubtedly a mark of inferiority in relation to the other Dominions—actually and practically it ensures to Canada an excellent safeguard that, while changes will never be denied, they will come when and on such occasions as Canadian public opinion is behind them. It may be better to guard our national unity and not to endanger it for a mess of theoretical pottage. However, once again whatever the law, we share with Great Britain in the equality of British nationhood. Great Britain is our political equal, and the power to change our constitution is ours for the asking.

Canada has made no contribution to political theory or to the science of government. The oldest dominion, it has followed British developments, practices, and customs. We walk by the still waters and along the quiet paths of traditions, and our historical origins lie across

creative politics. Be that as it may—we share with all organised communities in the fundamental facts that every country gets the government that it deserves, that a study of comparative governments is purely of intellectual interest, and that political institutions are of value in so far as they form a healthy framework for the highest community values.[1]

[1]For references see appendix.

CANADIAN EDUCATION: PAST AND PRESENT

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The idea of universal and compulsory education is of very recent origin in the world. Not until the latter part of the nineteenth century did the democratic ideal in education win a final victory over the aristocratic. The immediate result of this victory was the organisation of a machinery to give the benefits of education to every citizen of the state. The ultimate effects of this vast social experiment are still unknown, and its fullest implications still unrealised. British Canada was born into this changing world; some of the struggles of the aristocrats to retain their educational privileges were witnessed on her soil.

Before 1783 the settlement of Canada proceeded very slowly. The reason for this is to be found in the nature of her wealth. From the earliest times the fur trade proved profitable and was eagerly exploited. But pelts and permanent settlements are incompatible, hence the chartered companies never brought out the stipulated number of colonists. Had they done so, the problem of education would have arisen sooner. But the only educational work carried on prior to the American revolutionary war was that of the religious orders, and even here the main purpose was not that of furthering education, but the conversion of the native Indian to christianity.

After 1783 the real settling of Canada proceeded apace. Streams of United Empire Loyalists crossed the border and settled along the northern shores of Lake Erie and Lake Ontario. Immigrants from Great Britain also began to arrive—Highlanders, Lowland Scots, Ulster Irish, and men from Cornwall and Devon. These settled in blocks and imparted to each area distinctive characters which have persisted to the present day. Half-pay officers also came and to the wife of one of them, Susanna Moodie, we owe a Canadian classic, *Roughing it in the Bush*, which describes very vividly the trials of the early settlers.

The Constitutional Act of 1791 divided Canada into two provinces, Upper Canada (Ontario) and Lower Canada (Quebec). The Act of Union of 1840 reunited the two Canadas, and the British North America Act, 1867, again separated them and bestowed on them the names they now bear. It was in Upper Canada between 1791 and 1840 that the struggle for supremacy of the two rival philosophies

of education—the aristocratic and the democratic—took place. The tide of battle had finally turned by 1840 and victory lay with democracy.

Two names are inseparably connected with this controversy; that of Bishop Strachan, the leader of the aristocratic Anglicans; and that of Dr. Egerton Ryerson, the champion of the democratic non-conformists. Strachan worked unceasingly for the recognition of the Anglican church as the established church of Canada, and for the establishment of a system of education patterned after the English public schools leading up to a provincial university presided over by an Anglican bishop and taught by professors who were Anglican clergymen. Strachan got himself appointed to a number of important offices which helped him to further his views. In 1815 he was appointed to the Executive Council—the members of which were the immediate advisers of the Lieutenant-Governor. In 1823 he was appointed President of the General Board of Education (1823-1833) and in this office exercised almost sole control over the funds obtained from the sale of school lands. In 1827 he was made an archdeacon, and in the same year obtained a royal charter for King's College, becoming its first president and remaining in office until 1849 when it was re-organised as a non-denominational institution under the name it now bears—the University of Toronto. He became the first Bishop of Toronto in 1839. Nevertheless, with all these advantages, he failed to establish an aristocratic system of education. Even the grammar schools did not develop as they should have done, while the education of the masses remained lamentably backward. When his King's College scheme failed he established Trinity University, an Anglican institution, but by this time the cause for which he had fought so persistently was hopelessly lost.

The reason for this failure lay in the steady hostility of the masses to his plans. Although the House of Assembly failed to move him from his chosen path, its constant opposition retarded his pace and finally brought him to a standstill. The elected members, ignorant as many of them were, saw more clearly than ever was possible for Strachan, that education in a new land must work, like a fire, from the bottom up, and could never be made to work properly from the top down. Against considerable opposition they had forced through the Common School Acts of 1816, 1820, and 1824. The Act of 1816 provided for a local machinery of education by creating boards of trustees elected by the inhabitants. The schools they founded drew their support from government grants and rate bills on the parents of the pupils. The grants at first amounted to £6,000 a year, but these were reduced to £2,500 in 1820. The Act of 1824 placed the common schools under the jurisdiction of the General Education Board (mostly members of the

Family Compact) which was more than generously endowed by a grant of 190,000 acres of land.

But it was Egerton Ryerson who assembled and led the forces which accomplished the final overthrow of the aristocratic educational tradition in Canada. Ryerson had grown to maturity during the early decades of the nineteenth century, and by 1830 had become a foeman worthy even of the redoubtable Strachan. Although a descendant of United Empire Loyalists and in sympathy with tory political principles, Ryerson nevertheless fought strenuously for free education for the masses, unhampered by ecclesiastical control. In the *Christian Guardian*, of which he was the first editor, his writings rallied democratic opinion and made it articulate. Of the nature of the educational principles he stood for, the following extract from an early editorial gives a fair picture: "On the importance of education generally we may remark, it is as necessary as the light—it should be as common as water, and as free as air. . . . Education among the people is the best security of a good government and constitutional liberty, it yields a steady, unbending support to the former, and effectually protects the latter. An educated people are always a loyal people to good government; and the first object of a wise government should be the education of the people. . . . Partial knowledge is better than total ignorance; and he who cannot get all he may wish, must take heed to acquire all he can. If total ignorance be a bad and dangerous thing, every degree of knowledge lessens both the evil and the danger." Had these principles been acted upon by the aristocratic party then in power, it may safely be said that the abortive Mackenzie rebellion of 1837 would never have taken place.

Ryerson was appointed Superintendent of Education for Upper Canada in October, 1844. From November, 1844, to December, 1845, he toured Europe studying the various school systems. On his return he drafted the Education Bill of 1846 which was closely modelled on the lines of his *First Report on a System of Elementary Instruction* published the following year. In this Bill, which subsequently became law, Ryerson outlined a system which worked well and has served as the basis of all subsequent educational legislation in Canada outside the Province of Quebec. In this Act the powers and duties of the Superintendent of Education were clearly defined. Provision was made for the training of teachers. School sections were erected with boards of three elected trustees serving for three years, one trustee being elected annually. The method of apportionment of the government grant among the District Councils in proportion to the school population was clearly outlined. In Ryerson's first draft the local taxes for education were to be levied on property, but this wise pro-

vision, which would have given free elementary schools, was discarded in favour of the less democratic rate bills.

In 1853 the old established grammar schools, which up to this time had offered a classical education to a relatively few wealthy pupils, were placed under the jurisdiction of the Council of Public Instruction and its chief executive officer the Superintendent of Education. The missing link in the chain from the elementary school to the university was thus supplied.

The Act of 1871 consolidated the work of Ryerson. In regard to elementary education it established free and compulsory education; it provided for efficient inspection through county inspectors; it established a system of pensions for teachers; and it provided for the licensing of teachers under government direction. Of even greater moment were the provisions relating to grammar schools. Their designation was changed to High Schools in which provision was to be made for both sexes to acquire a knowledge of English and commercial practice, of natural sciences with special reference to agriculture, of Latin and Greek, and of French and German if desired by the parents. Superior high schools, called Collegiate Institutes, in which Latin and Greek were to be emphasized, were also established. The schools were to be supported by local taxes and government grants distributed, in part, according to the principle of payment by results. Finally, entrance boards were created to conduct the entrance examination from public into high schools. Thus, with certain important modifications, Ontario, and later the whole of Canada, adopted the system of horizontal statification of schools, common now to the whole of the North American continent, in contra-distinction to the vertical stratification common to England and the continent of Europe.

Ryerson remained in office until 1876 when the work of the Superintendent and Council of Public Instruction was taken over by a Department of Education under a Minister of the Crown. If Ryerson had favoured earlier this final act of democratising education he would have been more true to his fundamental principles, but it is also certain that the general progress of education would have been less rapid.

Since Ryerson's time no fundamental changes have been made in the educational system of Ontario. The work of training teachers which he inaugurated has been greatly extended. Ryerson's normal school at Toronto was followed by a second one at Ottawa in 1875. In 1877 the Minister of Education established county model schools giving short courses for rural teachers and granting third class certificates. Henceforth all teachers were to have some professional training in addition to two years or more of secondary education. In 1908 the standard was raised by replacing the short term model schools

with five new normal schools giving a year's professional training following a full high school course. Since 1885 provision has also been made for the training of secondary school teachers, first (1885) at Training Institutes attached to secondary schools, then at a central School of Pedagogy at Toronto, then (1897) at a Normal College at Hamilton, then at Faculties of Education in Queen's University and the University of Toronto, and finally (1920) at the Ontario College of Education of the University of Toronto. Since 1896 a system of continuation schools, now numbering 182 and maintained by local public school boards, has offered secondary education in rural communities where there is no high school. Vocational and technical education, generously aided by government grants, have expanded remarkably since 1900, and especially during the last decade.

An apparently disproportionate amount of space has been devoted to the development of education in Ontario. But in reality such an extended treatment is justified. The Ontario system came first and has developed furthest. Not only is it the prototype of at least six of the other provincial systems, but the democratic and wholesome character of Canadian education in general is due to battles waged and won over Ontario schools almost a hundred years ago.

In other provinces obscurantism raised its head. In the prairie provinces, for example, after the early and worthy efforts of the Roman Catholic missionaries had, by force of circumstances, proved inadequate to meet the educational needs of a rapidly growing community, constant attempts to prevent the establishment of public schools were made. Only one case will be cited, but it will serve to remind the reader of the immense progress that has been made in the short space of forty years. Compare the account given below with the picture that could be drawn of Edmonton's magnificent schools and university as they exist to-day.

In Shortt and Doughty's "Canada and its Provinces," Vol. XX, John M. MacEachran tells the following story about the early history of education in Alberta:

"The first school in the North-West Territories under government control was organised in Edmonton. An account published in a recent number of the Edmonton Bulletin of the events connected with its establishment, giving as it does an idea of some of the difficulties which were encountered, as well as affording a little sidelight upon life in the early days, deserves mention here. The account of what is described as 'one of the hottest fights that has ever been known in Edmonton, either in school or municipal matters,' runs as follows:

> It happened in 1884. A public school had been maintained by voluntary subscription for three years. The cost of its maintenance was not borne by the citizens equally. A few, a very few, as they always do, sustained the burden.
>
> The suggestion was made, therefore, that a regularly organised school district should be established. The Hudson's Bay Company, which owned the larger part of the school area, and some of the oldest settlers who were afraid of the taxes, immediately raised a chorus of protest. There was a howl of indignation.

It was at the first election of trustees when the fun took place. The Hudson's Bay Company, which fought the proposal strenuously, brought in from Slave lake, Calgary, and Athabasca Landing, those of their officers who had votes, and also influenced a large number of the local land-owners, in a big effort to swamp the supporters of the school. Matthew McCauley, the present warden of the penitentiary, was the returning officer, and in his own picturesque way he tells of the happenings of that eventful day.

It was at one o'clock on the day of the polling when matters began to get red-hot. The Hudson's Bay Company, which had told the people that they would be taxed for their flour and provisions and even their cook-stoves, if they voted for the proposal, brought in a number of their employees from the fort who were not known to have votes, the men voting as tenants of rooms at the company's buildings. This put the anti-school party five or six votes ahead.

As a counter to this move, Donald Ross, of the Edmonton hotel, brought up a big batch of his boarders. These had only one coon-skin coat among them, and one of them would go and vote and then 'hike' back and give the coat to the next man. 'Every time I saw the coon-skin coat coming,' says Mr. McCauley, 'I knew it was another vote for the school.'

All these men, the Bulletin said at the time, 'Swallowed the cast iron oath like little men.'

The votes were cast in three languages—English, French, and Gaelic, interpreters being required in the two latter to explain the oath.

One man, upon being asked by the returning officer which he wished to vote for—it was an open ballot—replied, 'Richard Hardisty.' Hardisty was then the chief factor of the Hudson's Bay Company. Upon being asked again he gave the same answer. Mr. McCauley therefore rightly disallowed his vote, although, of course, he knew all the time that the man wished to vote against the school.

Another man, a Highland Scotchman, upon hearing the oath, muttered, as he heard the words, 'that you are of age and not an Indian,'—'My God! An Indian! An' me a Hielandman of the first water!' He refused to vote—he was so disgusted.

At four o'clock the poll was declared closed, just as an anti-school voter appeared at the poll. The returning officer and scrutineers counted up the votes and announced as the result 54 for and 43 against the organisation of the school district.

Religious hatred in those days was practically unknown, a number of Catholics working for the establishment of the school district.

During the day, threatened destruction of the poll books did not materialise, but in the evening there were riotous scenes. There were free fights and black eyes which lasted for several days afterwards. Officials of the Hudson's Bay Company, and several prominent townsmen who opposed the establishment of the school district, were marked with representations of white fish, and the letters H. B. C., by opposing factions. It was a day which will long be remembered."

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And what of present day education in Canada? As only a sketch of the more significant features can be given within the limits of this short article, our purpose will be to select those in which Canadian education stands in vivid contrast to British education.

In the first place, therefore, the British visitor should remember that technically there is no such thing as a Canadian system of education. There are nine provincial systems with one of these, that of Quebec, differing rather markedly from the others. The British North America Act of 1867 granted sovereign powers over education to the several provincial legislatures, and these powers have since been jealously guarded. Only in a few relatively unimportant matters have rights over education been reserved by the Dominion. There

is, however, sufficient similarity in the spirit and character of the various systems for one to speak of a "Canadian Education" without straining overmuch either language or truth.

Secondly, Canada being a country nearly as big as the whole of Europe with a population of barely nine millions (2.4 per square mile) the whole problem of educational administration must be looked at from a different angle than that familiar to a British administrator. Canada is a pioneering country. In the northern parts of Ontario and Quebec farms are to-day being carved from the bush, while on the prairies the virgin sod is being turned. The typical school of Canada is a one-room school taught by a single teacher, usually a woman. Such schools are only to be found in Britain in the remote mountainous areas of Scotland, Wales, and the Lake District. If Britain's educational problem is an urban one, Canada's is predominantly a rural one.

Thirdly, the people of Canada are far from being a homogeneous group. They differ markedly both in race and religion. The French-Canadians, comprising almost one-third of the total population, are devout Roman Catholics and very tenacious of their language rights. The British-Canadians, making up more than one-half the population, are mainly Protestants. The remainder of the people, about 17 per cent. of the total, are mainly of European stocks—German, Scandinavian, Polish, and Russian. To satisfy the educational aspirations of these various groups is a task difficult enough to daunt the most intrepid person.

The provision of educational facilities in a sparsely populated area is best accomplished by the organisation of a highly centralised department. The departments of education of the several provinces exhibit this character. These departments are presided over by a minister of education who is the executive head of the department. He holds a portfolio in the cabinet of the party in power for the time being, and is responsible through the legislature to the people for the efficient administration of his department. He is usually assisted by a deputy minister of education and a superintendent of education. The former, as his title implies, is an executive official, the latter is rather more. Not only has he the supervision and direction of the schools under his personal control, but, being an expert, he furnishes the minister with technical plans and advice. The powers of a superintendent are usually very great. Assisting the above officials there is the usual departmental staff of the central office, and a number of inspectors in the field.

From the central department are issued the regulations regarding the conduct of the schools. Contrasted with the corresponding regula-

tions of the English Board of Education, Canadian ones are far more detailed and precise. Nothing is left to chance; very little to local initiative. The local trustees of education, and even the teachers, are regarded as insufficiently skilled to select a text-book, much less to draw up a course of study. Such centralisation is remarkably effective in a pioneering community, but if the leading strings are not loosened when the pioneering stage is passed, the system is apt to become too rigid. Some of the provinces have certainly reached the stage when the granting of greater powers to local authorities would be of undoubted advantage.

Unfortunately, however, the local administration of education in Canada happens to be the weakest feature in an otherwise admirable system. The local area for elementary schools is the school section or school district. For the school section, frequently containing but one school with a handful of pupils, three trustees are elected. Few powers are given to them and the office is not held in high repute. This arrangement would do well enough if it were not for the multiplicity of other local educational authorities which have been added as the country developed. There are special boards of trustees elected to run the high schools. Wherever dissentient religious minorities occur, separate school boards are elected to govern these separate schools as they are called. Continuation schools in Ontario which give a secondary education remain under the jurisdiction of boards of trustees for elementary schools. Vocational schools may be established by high school boards, but mining schools, which are also vocational, must have a special board appointed to govern them. Schools for the blind and deaf as well as the normal schools remain directly under the provincial department. Agricultural education is controlled partly by the Department of Education and partly by the Department of Agriculture. A College of Art has its special committee, and libraries have each a public library board. Only city boards are permitted to establish auxiliary classes, while residential industrial schools may be established either by town or city boards. The time is more than ripe when all these local efforts at educational control should be consolidated, and it would appear that concentration under county and city boards, as in England, is the logical, indeed the inevitable solution of the difficulty.

In Canada the secondary school is superimposed upon the elementary. Pupils must complete the full elementary course, which usually ends at fourteen, before they are allowed to begin their secondary studies. This arrangement of schools, which is only to be found in North America, is a most unfortunate one. Eight years (6-14) are too many to give pupils a control of the tools of learning; four years

(14-18) are too few for them to acquire the languages and sciences of the secondary school. The drawbacks of this arrangement are now generally recognised, but it is not easy to find a solution for it. In the United States junior or intermediate high schools (12-15) are being established to meet the difficulty, but up to the present little or nothing has been done in Canada.

Elementary schools are generally free and compulsory. Quebec, alone, has no compulsory education law. The Roman Catholic church in that province believes that a compulsory law would undermine the rights of the parents, and the Protestant minority has failed to move it from that position. In Ontario secondary education is also free, and in the Arts course at the provincial university the fees are extremely low. It seems as if a pupil in Ontario will soon be able to pass from the kindergarten to the end of his university course without paying a single dollar in fees.

In both elementary and secondary schools the courses of study are rather rigidly prescribed and special text-books are authorized. The authorized text-book is unknown in Britain; each head master is allowed to select the text that best suits the course of study in his particular school. Such freedom makes a Canadian gasp. Texts are uniform throughout the whole of each province. In many, penalties are attached to the use of unauthorized ones. These texts are selected by the departmental officials and receive authorization for periods running from five to ten years. Canadian text-books, when size and "get up" are taken into consideration, are the cheapest in the world. For the sum of 49 cents, the five readers for the whole elementary school course of Ontario may be purchased. However, it is only fair to state that this is not the true cost. The Department of Education bears all the preliminary cost of editorship and preparation of plates, but the results are still remarkable. The Ontario texts are widely used in other provinces, especially in Saskatchewan.

Another important aspect of Canadian education is the provision made for the training of teachers. In each province a serious attempt is made to secure a professional training for every teacher. The certificates granted are usually four in number—the third, second, and first classes of elementary teachers' certificates, and the high school assistant's certificate. The second class certificate is given to successful candidates after the completion of a whole year of normal training based on the academic preparation of a four years' high school course. The first class is given for a similar length of training but the requirements for entrance are those of honour matriculation (obtained after 5 or 6 years in a secondary school). The third class is given to students who take shorter courses of training. The academic prerequisite of

the high school assistant's certificate in Ontario is a university degree. The professional training extends over a full university session. In Ontario no teacher can now be appointed to a high school or collegiate institute unless he is the holder of a high school teachers' certificate. This high standard is equalled only by the State of California; all other states and countries fall below it. A corollary of these high requirements is the relatively high salaries that Canadian teachers command. A trained secondary teacher in Ontario obtains $1,800 to $2,400 during the first year of teaching, and may rise ultimately to a principalship worth $5,000 a year.

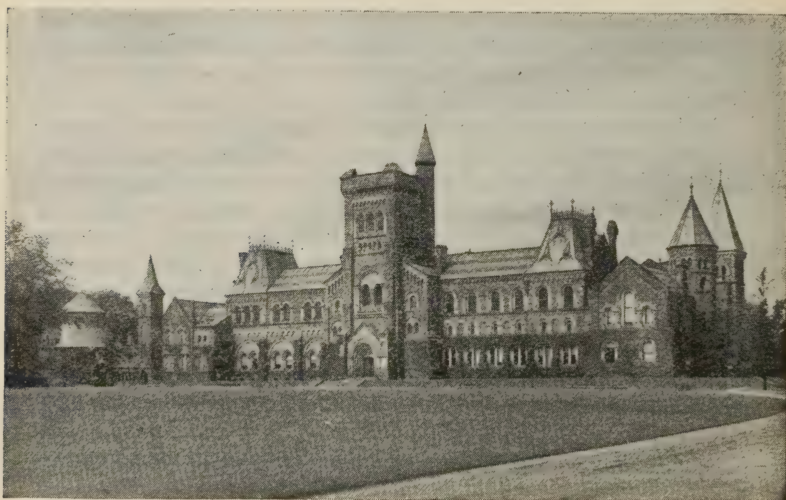

FIG. 6. UNIVERSITY COLLEGE, UNIVERSITY OF TORONTO

University education is wide-spread. Each province supports at least one university. Ontario, New Brunswick, and the four western provinces have state universities. The University of Toronto, the state university of Ontario, is a federated university, that is, it has attached to it in federal fashion a number of denominational colleges. A federated university for the maritime provinces situated at Halifax is in process of organisation. The undergraduate courses are those leading to the B.A. degree and to the various professional degrees. In Toronto both pass and honour courses are offered in the Faculty of Arts. The latter, however, differ materially from the honour courses of a university in Great Britain. In the first place a higher entrance

requirement, honour matriculation, is demanded of the Canadian student. Honour matriculation requires an additional year, sometimes two, of high school education, making five or six in all, whereas pass matriculation, the entrance examination to the pass or general course, needs but four. In the second place the pass courses and honour courses within the university are sharply differentiated. The pass courses are organised for those students who have no definite bent in the direction of a particular field of study but who desire some acquaintance with the general field of knowledge; the honour courses are highly specialised and are devised for students who have already discovered their particular interests and have a definite leaning to the intensive study of a distinct group of subjects. It is from among the group of honour students that the rapidly developing School of Graduate Studies draws the majority of its students.

Another important variety of Canadian education is the technical and vocational, including agricultural education. These forms of endeavour are a few which the British North America Act allows the Dominion to support. Liberal grants are made by the Dominion government to each of the provinces in support of agricultural and technical education. The grants are distributed partly as a block grant and partly in proportion to the population of the several provinces. Already magnificent technical schools are springing up in each of the populous centres of the Dominion and the movement bids fair to become one of the most important in Canadian education.

In the subjoined appendix will be found three tables giving the most recent statistics that are available for the Dominion. They have been specially prepared by Mr. S. A. Cudmore of the Dominion Bureau of Statistics.

APPENDIX

Statistical Summary of Education in Canada by Provinces, 1922 or latest year reported, Number of Pupils Attending Educational Institutions

No.	Type of Institution	P.E.I. 1922	N.S. 1922	N.B. 1922	Quebec 1921-22	Ontario 1921-22	Manitoba 1922	Sask. 1922	Alberta 1922	B.C. 1922	Total
1.	Ordinary day schools under public control	18,323	114,229	77,774	462,679[7]	632,123[16]	136,876	183,935	142,902	91,919	1,860,760[27]
2.	Agricultural, Commercial, Industrial and other Technical Schools, including all evening schools but not short courses in universities and colleges	166	7,086[1]	1390[5]	11,046[8]	44,450[17]	5,802[21]	1,779[23]	3,202[25]	5,628[26]	80,549
3.	Schools for teacher-training	341	1,090[2]	358	1,376[9]	2,431[18]	790	1,462	760	685	9,293
4.	Indian schools	38	276	278	1,539	3,625	1,804	1,444	1,203	2,505	13,021
5.	Schools for the blind and deaf	8	226	67[6]	579	481	131	74	54	75	1,695
6.	Business Colleges (Private)	75	698	723	4,248	12,229	1,928	649	2,304	1,075	23,929
7.	Private Elementary and Secondary Schools	497	1,390[3]	391	54,671[10]	7,706[19]	563[22]	2,514	2,489	1,283	71,504
8.	Preparatory courses at universities and colleges	135	372	322	........[11]	3,321	251	8	653	74	5,136
9.	Short, Special and Correspondence courses at universities and colleges	....	490[4]	....	2,629[12]	4,299	1,067	15,036[24]	344	217	24,082
10.	Classical Colleges	....	....	....	9,502[13]	....	....	....	....	....	9,502
11.	Affiliated professional and technical colleges (regular courses)	....	292	....	1,572[14]	3,046[20]	759	54	64	115	5,902
12.	Universities (regular courses)	95	1,293	486	5,428[15]	6,168	1,874	799	1,088	1,014	18,245
	Grand Total (exclusive of duplicates)	19,678	127,442	81,789	555,269	719,879	151,845	207,754	155,063	104.590	2,123,618
	Population of 1921	88,615	523,837	387,876	2,361,199	2,933,662	610,118	757,510	588,454	524,582	8,788,483

1. Including 3,600 in special agriculture courses over and above the students of the Agricultural College elsewhere enumerated; 2,044 in industrial training over and above the students of the Technical College elsewhere enumerated; 742 in home economics and 700 in coal mining and engineering schools.
2. Including 352 at the Normal College and 738 at inspectorial teacher-training institutes.
3. Exclusive of pupils in preparatory schools which have already been included in item 8.
4. Including 160 in agricultural courses, 23 in industrial courses, 30 in home economics and 78 in navigation and 199 in correspondence courses.
5. Including 255 in day and 1,135 in evening technical schools. The number in agricultural schools is not included.
6. In institutions at Halifax, N.S., but supported by the province.
7. Including 457,880 in elementary and model schools and academies under control of commissioners and trustees, and 4,799 in nursery schools most of which are under control—figures of 1920-21.
8. Including 6,452 in night schools; 2,261 in dress-cutting and dress-making schools; and 3,319 in schools of arts and trades—figures of 1921-22.
9. Figures of 1920-21.
10. Including all subsidised primary schools reporting statistics, but not under control of commissioners or trustees,—figures 1920-21.
11. Included with the figures of classical colleges and private schools.
12. Including 1,280 in evening courses at technical schools; 224 in special courses at technical schools; 315 in short courses at agricultural colleges; 158 in evening courses at the school of higher commercial studies and 66 in short courses at the Wesleyan Theological College,—figures of 1921-22.
13. Including 9,033 in the 21 classical colleges and 469 in independent non-subsidised classical schools. Figures 1920-21.
14. Including 359 in dairy schools; 736 in regular courses at the technical schools; 278 in regular courses at the college of agriculture; 119 in regular courses at the school for higher commercial studies and 80 in regular courses at three protestant theological colleges—figures of 1921-22.
15. Excluding preparatory short courses and such figures as have already been included in items 8, 10, and 11,—figures of 1920-21.
16. Including public, separate, continuation and high schools and collegiate institutes all day courses—figures of calendar year 1921 for the public and separate schools and of the school year 1921-22 for the other schools
17. Including 5,344 in full time day courses, 574 in part time day courses; 1,604 in day special courses and 32,545 in evening courses and industrial, technical and art schools; 2,533 in night elementary schools; 1,635 in night high schools and 215 in the three agricultural schools at Monteith, Whitby, and Kemptville. Figures of 1921-22.
18. Including normal schools and autumn and summer model schools, but not the College of Education, which is a faculty of the University of Toronto.
19. Excluding 432 in preparatory schools already included in item 8.
20. Excluding duplicate registrations at universities and colleges. Where duplicate registrations occur, they are credited to the colleges and deducted from the universities The same is done in the case of other provinces.
21. Including 3,507 in day and 2,295 in evening technical schools. Figures of 1921-22.
22. Excluding 136 in preparatory schools already included in item 8.
23. Including 961 in day and 818 in evening vocational schools—figures of 1921-22.
24. Including 249 in extra mural courses, and 14,778 in extra mural agricultural courses.
25. Including 1,362 in day and 1,840 in evening vocational schools.
26. Including 551 in industrial training courses, 111 in home economics, 1,025 in commercial training courses, 52 in English classes for foreigners; 464 in correspondence courses and 3,425 in evening courses not already included.
27. Including 309 in the Yukon and the North West Territories.

DISTRIBUTION AND ATTENDANCE OF PUPILS IN ORDINARY DAY SCHOOLS UNDER PUBLIC CONTROL

No.		P.E.I. 1922	N.S. 1922	N.B. 1922	Quebec 1921-22	Ontario 1921-22	Manitoba 1922	Sask. 1922	Alberta 1922	B.C. 1922	Total
1.	Number of boys enrolled.....	9,273	57,028	35,431	248,544	318,350	....	93,644	72,093	46,833	....
2.	Number of girls enrolled......	9,050	57,201	35,915	264,107	313,773	....	90,291	70,809	45,086	....
3.	Total in the first six grades..	14,829	89,264	63,518	465,945	465,904	111,377	153,389	112,508	64,801	1,541,535
4.	Total in intermediate and secondary grades..........	3,825	24,965	7,828	51,405	166,219	25,499	30,546	30,394	27,118	367,809
5.	Total in secondary grades....	....	11,039	2,693	....	54,870	10,729	10,714	10,762	8,944	....
6.	Boys in secondary grades.....	....	4,202..	....	....	21,924	....	4,419	4,707	3,929	....
7.	Girls in secondary grades.....	....	6,837..	....	....	26,861	....	6,295	6,055	5,015	....
8.	Number of pupils in graded schools..................	6,570	72,091	36,366	....	450,000	82,000	85,000	76,691	....	....
9.	Number of pupils in ungraded schools..................	11,753	42,138	34,980	....	182,000	54,000	98,000	66,211	....	....
10.	Average daily attendance.....	12,338	70,410	51,590	397,172	446,396	95,433	119,041	100,515	75,258	1,368,553
11.	Average number of days each pupil attended during year..	....	136	145	....	....	130	127	131	....	....
12.	Average number of days schools were open during year....................	....	196	190	....	....	187	1,893	179	....	....
13.	Percentage of total attendance in average attendance......	67.4	69.5	72.3	77.47	70.00	69.7	64.7	70.3	82.2	71.6

Teachers, Accommodation and Expenditure in Schools under Public Control, 1922 or latest year reported

No.		P.E.I. 1922	N.S. 1922	N.B. 1922	Quebec 1921-22	Ontario 1921-22	Manitoba 1922	Sask. 1922	Alberta 1922	B.C. 1922	Total
1.	Teachers in schools under public control	611	3,208	2,246	17,201	16,147	3,893	7,023	5,787	2,994	59,110
2.	Male teachers	122	263	180	2,631	2,378	924	1,865	1,428	700	10,491
3.	Female teachers	489	2,945	2,066	14,570	13,769	2,969	5,158	4,359	2,294	48,619
4.	Number of school districts	473	1,773	1,331	7,377	....	2,094	4,543	3,297	716	....
5.	Number of school houses	473	1,863	2,063	7,543	7,231	1,936	4,268	2,861	991	29,229
6.	Number of classrooms in operation	609	2,982	2,065	13,274	....	3,782	5,717	4,485	2,823	51,000 (approx.)
7.	Number of ungraded one roomed schools	415	1,431	1,196	....	4,989	....	3,506	2,588	....	....
8.	Average number of pupils to a classroom	30	38	38	38	....	37	32	32	33	....
9.	Total expenditure on education	428,869	3,646,570	2,657,046	22,122,979	36,739,564	10,898,340	13,442,417	9,915,706	7,833,578	107,685,669
10.	Total expenditure on education by the government	271,103	616,389	381,075	2,351,471	3,475,713	1,058,292	1,491,610	1,146,722	3,141,738	13,934,113
11.	Total expenditure on education by ratepayers, etc.	157,766	3,030,181	2,275,971	19,771,508	33,263,851	9,840,048	11,950,807	8,768,984	4,691,840	93,750,956
12.	Expenditure on teachers' salaries	....	1,740,731	....	....	19,036,129	5,016,903	7,273,200	5,213,011	....	....
13.	Average annual cost per pupil enrolled	21.21	31.92	34.17	43.15	54.31	79.62	73.08	61.24	85.23	53.77
14.	Average annual cost per pupil in daily attendance	31.49	45.92	51.50	55.70	82.30	114.23	112.95	87.09	103.73	76.10

PUBLIC LIBRARIES OF CANADA

W. O. Carson, Esq.
Inspector of Public Libraries for Ontario

The Canadian people believe in public libraries as a means of promoting popular education and good citizenship. The last decade has seen a rapid growth in the development of these democratic institutions. Local authorities from the Atlantic to the Pacific have been enlarging and improving their library service, and appreciation has been shown by a corresponding response on the part of the people.

The maritime provinces on the east and British Columbia on the west have their library associations and a fair number of modern public libraries. Dawson City, in the Yukon Territory—"the land of the midnight sun", has its modern public library. Alberta, Saskatchewan, and Manitoba have nearly sixty flourishing libraries. Quebec has a magnificent new public library in Montreal, and the public library of Westmount is noted throughout the Dominion for the excellence of its work. While the free public library has not taken root throughout that province, semi-public and institutional libraries are well represented, many of them containing collections of books of great value.

Ontario has a very large and growing library system; four-fifths of Canada's public libraries are in this province. With its 466 public libraries, Ontario has the largest number, in proportion to its population, of any country, state, or province in the world. The writer, being more familiar with the system in Ontario than with the general situation throughout the Dominion will devote the major portion of the limited space to that province.

The Ontario Government's Department of Education includes among its several branches a "Public Libraries Branch", its chief official being the Inspector of Public Libraries who is under the direction of the Minister of Education. Public libraries, therefore, are part of the educational system of the province. In the Public Libraries Act the libraries have been given advanced legislation. Cash grants are paid annually to the libraries according to regulations that state the basis upon which grants may be earned. Professional advice is given to libraries, travelling libraries are maintained for free service to the sparsely settled parts of the province, a quarterly periodical is published

in the interest of library work and book-selection, and a school for the professional training of librarians and assistants is maintained.

The Ontario Library School has trained 261 persons since 1916: each year a few students have been trained for libraries in other provinces. While the professional school is under provincial control, and considerable instruction is given by the Minister's librarians, the Toronto Public Library co-operates with the Public Libraries Branch by furnishing accommodation and practising facilities, and by permitting certain of the specialists on the library staff to serve as lecturers in the school.

The individual libraries of the province are municipal institutions, controlled by a public library board, and supported chiefly by municipal tax; the legislative grant, while helpful to libraries, especially the small ones, is comparatively small. Each library is free to develop according to the ideas of the local board. The Act and the Regulations place the maximum authority and responsibility on municipal public library boards.

The spirit of the modern public library has been at work in Ontario for a long time. Good book-selection, the application of library science, and the employment of means to reach and attract the public have been effective in extending good library service to larger and still larger numbers of people. The patronage of our public libraries has leaped from a trifle more than four million to nine million in the brief period of eight years. It is believed that the demand for books of high quality has increased in the same period.

The libraries vary greatly in size, therefore the standards cannot be stated in general terms without dividing the institutions into groups —very large, large, medium-sized, and small.

The Toronto Public Library is the only very large one in Ontario; in fact it is the largest and most elaborate public library system in the Dominion. Toronto has a large main library in the heart of the educational section of the city and sixteen well-equipped branches located in as many prominent districts of the municipality. This system employs a chief librarian and about one hundred and twenty-five assistants. It is a notable fact that ninety per cent. of the members of the library staff have received formal training in modern librarianship.

The circulating division is doing work of a high order and quite worthy of the professional talent that is engaged in that branch of the work. Unusual emphasis is given to the reference division of this library. The fine reference reading-room accommodates 200 readers, and at busy hours every seat is occupied. The collection of books, fragmentary material, and maps is organised according to the best methods known to modern librarianship, and the personal service rendered by the reference assistants is of a very high order.

The children's division of the Toronto Public Library has received generous commendation, especially of late. Toronto has a separate building devoted wholly to work with children, and takes pride in having established the first exclusively children's library in the British Empire. Nearly thirty trained children's librarians devote all their time to work with young people. The library begins with small children at the story-hour, when the assistants who are trained in the art of story-telling, tell stories from the world's greatest literature. The chief librarian has been instrumental in introducing stories from early Canadian history and other series of tales as ground work for the instilling of sentiments of good citizenship. The children's libraries are equipped with selections of books of the highest order and the trained assistants are doing effective work in guiding the reading habits of the younger generation. Apart from the immense patronage that the children's rooms receive from Canadian boys and girls, a visitor is deeply impressed with the excellent work that is being done in the interest of Canadian citizenship amongst children of foreign parentage. Visitors to Toronto who are interested in education and sources of higher social influence should take the opportunity of visiting a typical children's room in the Toronto Public Library system.

Modern library science is seen at its best in this system. The classification and cataloguing division, in charge of ten specialists, has organised the books and other material in a manner that has made the wealth of the library easily accessible. This phase of the library's work is an excellent expression of all the niceties and exactitudes of library technique. Although the importance of its results is little known to the public, the work of the institution owes a very great deal to the treatment of material by this highly efficient division.

The main library building is a fair example of library architecture and has almost outgrown its present accommodation. A special feature of interest to visitors is the John Ross Robertson collection of paintings and prints illustrative of Canadian history. This great collection occupies a large room in the main reference library and is in charge of an experienced librarian. The branch buildings are well adapted for their purpose. The most recently built are admirably planned and at the same time depart from the stereotyped style of library building. For example, the plans of three of the buildings are adapted from the type of architecture of the old grammar schools that were in use in England in the days of Shakespeare. The plans lend themselves to all the requirements of a model branch library building.

The library board of Toronto is composed of men who have served over long periods of time, and with their chief librarian, Dr.

George H. Locke, deserve the encomiums of the people of Toronto for the success of their efforts. The Toronto Public Library contributes generously toward the advancement of library affairs throughout Ontario, chiefly through co-operation with the Department of Education.

Ottawa, Hamilton, and London would represent our large libraries, each having a first class central library with from one to four small branches. The general character of their work resembles that done in Toronto except that the organisations are smaller and the departments not so highly specialised. The extent and quality of their service is good.

Twenty smaller cities represent another type, where the several departments of the work are carried on under one roof, and by staffs ranging from three to seven persons. In the majority of these libraries a high type of service is being given. They differ somewhat from the large libraries in the same way that the large ones differ from the very large system.

Another type consists of about 70 town libraries situated in places with populations ranging from 1,500 to 10,000. The more advanced town libraries employ trained librarians and do an excellent class of work. One of our best examples of what a model library should be belongs to this class. Considerable effort is now being expended to encourage the smaller town libraries to imitate the standard set by the cities.

Ontario is especially proud of more than 300 very small public libraries in rural districts and villages. These institutions can give model library service only in good book-selection and encouragement in the use of books. In Ontario the rural library problem is difficult of solution, as it is in all other countries, and the extent of the territory presents added difficulties. While the province has a very large number of these small libraries on its register and the majority of them are making good use of their opportunities, it has been found here as elsewhere that the small community does not form a sufficiently large unit to provide an extensive and varied collection of books for the people and a qualified librarian to serve as an influence among the readers. Considerable time may elapse before counties or large rural districts will be accepted by the people as units for library service. Public interest in rural sections must express itself on this subject before much headway can be made. The matter of more elaborate library organisation and a local tax will scarcely make an appeal until a stronger desire for a large library service with a willingness to meet the cost is in evidence.

Communities that have no library service of their own may secure service from the Travelling Library Section of the Department of Education. Several hundreds of cases, provided by this service, are always in use throughout the sparsely settled parts of Ontario.

ANGLO-CANADIAN LITERATURE

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One writes of Canadian literature with the assumption that the visitor from overseas has on his shelves a few volumes of Leacock, possibly his grandfather's copy of *Sam Slick*, and if he is particularly curious about our intellectual output a compendium of specimens that will represent in the usual unconvincing fashion of such compilations our national effort in prose and verse. He will probably be at a loss to mention any book that exhibits the tone and temper of our country, and it is possible that he may be incurious enough to accept Fenimore Cooper or Francis Parkman as his sufficient guide. We certainly have not deluged Europe with masterpieces, but evidences are not wanting of an increasing ferment of intellectual activity in the Dominion, which must inevitably produce results of international consequence. We publish annually several hundred volumes by Canadian authors and mainly on Canadian themes, which from the standpoint of quantity is not a negligible result for a country that has not yet developed a professional literary class. And in all modesty it may be affirmed that the quality of this yearly output is steadily improving. A few years ago the Canadian novel was non-existent (for we are content to leave the names of Richardson, Mrs. Leprohon, and Kirby to the enthusiasm of the pious antiquarian); but now our fiction is more confidently artistic in form and is essaying the task with some measure of success of explaining the Canadian to himself. It is a disconcerting thing, perhaps, that a foreigner like Hémon should have discovered with a flash of fine divination the possibilities of romance that lay in a few rude acres of our soil, but his example may prove the incentive that will reproduce the miracle. Drama even more than fiction is the touchstone by which the virtue of a nation's literature is estimated, and here the signs and portents are no less promising from still more unpropitious beginnings. History with us has enjoyed a more continuous activity, but it is only in the last two decades, with the effective organisation of our archives and with the stimulus of university teaching in the direction of research, that scholarly methods have begun to prevail. Poetry is not susceptible of the same organisation

or control, and since it is more spontaneous in its origin we might have expected here an earlier approach to excellence. It is depressing however to note how long the "tuning up" process has lasted with us, how meagre still the choir, and how thin if pure the volume of sound that proceeds from its united efforts.

It is not necessary to apologise for, but merely to explain the tardiness of our development, and until recent date the paucity of our literary performance. We have had of course a lot to do in putting our house in order, and a pioneer condition, however much it may toughen the fibre of a race, does not promote the flexibility of mind nor provide the leisure that creative activity demands. Literature is an affair less of solitude than of contacts, and meditations in a log hut are rarely written by the man that built it. Conditions are more propitious now, but we still suffer in a literary sense from being a young country born into the old age of the world. All that tradition counts for in the literature of a European country we must forego. Our literary past is the literary past of England; we have not yet had time to strike roots for ourselves. Other nations have a progressive tradition and a harmonious evolution little interrupted by artificial considerations; whereas with us literature is compelled to be almost completely artifice. England had her spontaneous ballad and epic beginnings, her naïve miracle plays that responded to an imperative need of the time, her share in the exhilaration of the renascence, when even imitation was an exercise of the original creative faculty; and upon these broad foundations she built her great self-conscious modern literature, each new generation of writers urged on by impulses from the past, reinforcing its lessons here, violently reacting from its opinions there, and always excited by contact with the vivifying ideas that the present hour engenders.

The following sketch will give in smallest compass the story of our literary development. There will of necessity be no pretension to completeness. Only the most representative writers can be named, and if the critical appraisement savours of arbitrariness the constraint of brevity must serve as my palliation and my excuse.

The present provinces of Nova Scotia and New Brunswick claim that owing to their proximity to New England they obtained in the post-revolutionary period emigrants of a better class than those who sought refuge in the region of Quebec, Montreal, and the remoter west; and they attribute their early intellectual leadership to this circumstance. The facts at least merit examination. By the Treaty of Utrecht in 1713 Acadia with its sparse French population was ceded to Great Britain. There was, however, no appreciable influx of English speaking inhabitants until in 1755 the expulsion of the Acadians

destroyed the French ascendency. The Revolution followed with its flow of United Empire refugees from the New England states, and by 1786 their numbers had grown to thirty thousand. The combined numbers in Quebec and what is now Ontario were appreciably less, but it would be invidious to say that in character or intelligence they were of inferior type. And an important factor in the situation is that the influential nucleus of population in Quebec and Montreal was the virile Scottish stock that controlled the fur-trading industry of Canada. An inference, then, that we should be entitled to make from the facts is that the intellectual dependence of the maritime provinces would be upon New England, whereas the affiliations of the west would be more directly with Britain. This comparison would be more important if any serious intellectual rivalry existed, or anything that the most eager patriotism could describe as a race for supremacy. In the east until the advent of Haliburton and Howe the efforts to produce literature were singularly futile, whereas in the west these Scottish traders of whom we spoke, concerning themselves only with giving a faithful account of things seen and experienced, achieved results of permanent value. Rude writers these men of adventure often were, but of a refreshing and invigorating uncouthness and a forthright sincerity which could not flow in concert with academic polish and anaemic perfection. "Before I conclude," writes one of them, "I must beg to inform my readers that they are not to expect the charms of an embellished narrative or animated description. The approbation due to simplicity and truth is all I presume to claim; and I am not without hope that this claim will be allowed to me." This man was Alexander Mackenzie (1763-1820) and his book published in 1801 was "Voyages from Montreal on the River St. Lawrence, through the Continent of North America, to the Frozen and Pacific Oceans, in the years 1789 and 1793." Three other Alexanders may be named in our literature of exploration, the two Henrys, uncle and nephew, and Alexander Ross (1783-1856) whose book "Adventures of the First Settlers on the Oregon or Columbia River" (1849) is one of the most vivid of its type. Hearne and Harmon are also memorable figures with whom our list may close.

Joseph Howe (1804-73) and Thomas Chandler Haliburton (1796-1865) are the first distinguished names in the literary history of Nova Scotia. Howe's efforts were predominantly journalistic and political, but it was his ambition to make his paper the *Nova Scotian* contributory to literature. To this end he designed *The Club*, founded on the model of the *Noctes Ambrosianae*, and it was in collaboration with him that Haliburton first discovered his talent in the field of the character-portrait and satire. The famous Sam Slick volumes are the direct outcome of this genial experimentation, and with Sam Slick American

humour was born. *The Club* was discontinued in 1835, but immediately afterwards Haliburton contributed a series of satiric sketches to the *Nova Scotian* whose success was so great that he published in Halifax in 1836 his collected papers under the title of *The Clock-maker: or the Sayings and Doings of Samuel Slick of Slickville.* A second series followed in 1838, and a third in 1840. An analysis of their contents cannot here be attempted. Suffice it to say that though much of the humour seems now to have evaporated from the compound the books are still eminently readable. Their continued popularity and widespread appeal are almost sufficient to stifle criticism. Since the original issue at Halifax, nineteen editions have appeared in the United States, twenty-four in England, four in France, and one in Germany. *The Attaché, or Sam Slick in England* was an unsuccessful continuation of the earlier series, though Haliburton found a return to favour in *Sam Slick's Saws and Modern Instances* of 1853. It is more difficult to envisage Sam in the Court of St. James than as an investigating passenger on the high seas of Nova Scotia.

The *Literary Garland* (1838-51) did not vie with the *Nova Scotian* in political importance, but like that more famous publication it contrived to make itself a focal point for literature in Upper and Lower Canada. Through its columns John Richardson, Charles Sangster, Mrs. Leprohon, Mrs. Moodie, and Mrs. Traill made their appeal to a limited, an uncritical, but eager public. Richardson wrote novels in the Cooperesque vein, *Wacousta* (1832) his best effort being an ill-sustained work with some effective local colour in the midst of its wildness. Mrs. Leprohon did historical romances of the old régime, and Sangster was an indifferent poet. Our most notable poet of pre-confederation days was Heavysege whose dramatic poem *Saul* has been strangely overpraised by Longfellow, Hawthorne, and Patmore.

Having thus hastily brought the story of our literature down to the period of Confederation I may content myself in conclusion with indicating to my supposititious trans-Atlantic visitor the writers of this later time with whom he will find it most profitable to concern himself. He will discover at last a poetry that without the marks of pre-eminent greatness upon it will still appeal to him as sound and genuine. Isabella Valancy Crawford (1850-86) unrecognised, unfriended, and poor produced much verse whose singular merit we are only beginning to appreciate. If one can speak of the founders of a school of Canadian verse the name must be applied to the group of men born a decade later—Lampman, Campbell, Roberts, Carman, and D. C. Scott. The two first named are dead. Mr. Roberts and Mr. Carman, both natives of New Brunswick, have spent the major portion of their creative careers in the United States, the former now living in England,

and the latter fortunately again a frequent visitor to the country of his birth. Lampman, Scott, and Campbell were Ontario men who attached themselves to the civil service in Ottawa where Mr. Scott still lives, having for many years occupied the distinguished post of Deputy Superintendent General of Indian Affairs. Less distinguished for the poetical quality of his work but more characteristically Canadian in theme and treatment was William Henry Drummond (1854-1907) who studied the French Canadian *habitant* with sympathy, insight, and humour. Canon F. G. Scott is another contemporary whose poetry merits attention. Pauline Johnson (1862-1913) the Indian poetess should not be, and Marjorie L. C. Pickthall (1883-1922) cannot be, forgotten. Since Lampman's, her death has been the severest loss our poetry has known. Her talent was strong and pure and tender, and her feeling for beauty was not more remarkable than her unrivalled gift for expressing it.

Having named the ancestors, living and dead, of our Canadian poetry, I must pass in silence our interesting contemporary activity and conclude with a few remarks upon the present condition of our prose literature in fiction, in drama, and in history.

Sir Gilbert Parker is, by common consent among our seniors, the outstanding figure. His measure by the English scale is known, and by applying this test "the visitor" may arrive at a rough valuation of the importance of our writers in the larger movements of world fiction to-day. Here we are not concerned with comparative estimates, but from the standpoint of a narrow nationalism we may appreciate the remarkable increase in the annual production of novels as evidence that the professional writer has at last made his appearance in Canada. The censor's objection that these are often masquerading amateurs who have mistaken their profession and thrive on the gullibility of an undiscerning public will not alter the facts, and I am securely confident that from this confused ferment of activity important results will ultimately emerge.

Mr. Vincent Massey contributed a year ago to the *Queen's Quarterly* a well-reasoned article on *The Prospects of a Canadian Drama.* The inclusion in the title of the word *prospects* was not without intention, and he admits that "it is, of course, almost as easy to be witty about the Canadian drama as about the Canadian navy. They each, at the moment, may seem to represent a well-meaning but rather insignificant effort to complete our national equipment—to suggest a pious aspiration rather than reality. The Canadian drama, as a matter of fact, at present represents perhaps no more than twelve or fifteen produced plays. On this slender foundation what can be built? The inquiry has all the romance of an uncharted voyage into unknown seas."

If we cannot proclaim a national drama it is still not an offence to modesty to explain the changed conditions which must soon convert our "pious aspiration" into reality. No development seems possible on the basis of our present commercial drama, so long at least as it continues to be controlled from Broadway. We must accept this domination for many years to come, but we can mitigate its influence by forming independent centres of dramatic activity in our larger towns. Our "Little Theatre" movement has accordingly developed in response to an imperative need. In our varied experiments throughout the Dominion we have undoubtedly had the Abbey Theatre in mind, and the creative energy that its establishment engendered. Dig your channel, tap your source, and the waters will flow. Determination can perform the first part of the process, fortune the second, and if the fountain refuses to gush we can only blame the incurable aridity of our soil. Merrill Denison, Carroll Aikins, Bertram Forsyth, D. C. Scott, Fred. Jacob, Isabella Ecclestone Mackay, and the late Marjorie Pickthall have indicated by their initial efforts that the metaphor will not miscarry.

Our history as I have said above is exceptionally healthy, and with history I may include the literature of biography and memoirs. We are in the documentary age of history when the verification of sources and the orderly presentation of material are the predominant consideration. In this respect our Canadian historians can sustain comparison with any who are writing to-day, and their regard for accurate statement has not blinded them to the importance of values that are more purely literary. The histories they give us to-day have therefore the advantage of being both readable and reliable.

Selected List of Recent Canadian Books

Drama

Denison, Merrill.—The Unheroic North; four Canadian plays.
Mitchell, Roy.—Shakespeare for Community Players.
Pickthall, Marjorie.—The Woodcarver's Wife.

Poetry

Bourinot, Arthur Stanley.—Poems.
Broadus, Edmund Kemper and Broadus, Eleanor Hammond.—A Book of Canadian Prose and Verse.
Callaghan, Francis.—The Reed and the Cross.
Campbell, William Wilfred, comp.—The Oxford Book of Canadian Verse.
Campbell, William Wilfred.—The poetical works of Wilfred Campbell, ed. with a memoir by W. J. Sykes.
Carman, Bliss.—Ballads and lyrics; Later poems.
Crawford, Isabella Valancy.—Collected poems, ed. by J. W. Garvin.
Drummond, William Henry.—The poetical works of William Henry Drummond, with an introduction by Louis Fréchette.
Johnson, Emily Pauline.—Flint and Feather.
Lampman, Archibald.—Complete poems, ed. with a memoir by D. C. Scott.
McCrae, John.—In Flanders Fields, and other poems.
MacDonald, Wilson.—The Song of the Prairie Land.
Norwood, Robert Winkworth.—The Piper and the Reed.

PICKTHALL, MARJORIE.—The Drift of Pinions.
PRATT, EDWIN J.—Newfoundland Verse.
ROBERTS, CHARLES G. D.—Poems, new complete edition.
SCOTT, DUNCAN CAMPBELL.—Beauty and Life; Lundy's Lane and other poems.
SCOTT, FREDERICK GEORGE.—Poems.
SERVICE, ROBERT WILLIAM.—Songs of a Sourdough.
WATSON, A. D. AND PIERCE, L. A.—Our Canadian Literature.

Classed Books

BAKER, RAY PALMER.—A History of English Canadian Literature to the Confederation.
BARBEAU, MARIUS.—Indian Days in the Canadian Rockies.
BORDEN, SIR ROBERT LAIRD.—Canadian Constitutional Studies.
BRYCE, GEORGE.—A Short History of the Canadian People.
BURPEE, LAWRENCE JOHNSTONE.—Among the Canadian Alps.
COLEMAN, ARTHUR PHILEMON.—The Canadian Rockies, new and old Trails.
DAWSON, SAMUEL EDWARD.—The Saint Lawrence Basin and its Border-lands.
DENISON, GEORGE TAYLOR.—Recollections of a Police Magistrate.
EDGAR, PELHAM.—Romance of Canadian History, ed. from the writings of Francis Parkman.
FALCONER, SIR ROBERT ALEXANDER.—Idealism in National Character.
GRANT, WILLIAM LAWSON.—Ontario High School History of Canada.
HALE, KATHERINE.—Canadian Cities of Romance.
HALIBURTON, THOMAS CHANDLER.—Sam Slick, ed. by Ray Palmer Baker.
HAM, GEORGE HENRY.—Reminiscences of a Raconteur; between the '40s and the '20s.
HAMMOND, MELVIN ORMOND.—Confederation and its Leaders.
HARMON, DANIEL WILLIAMS.—A Journal of Voyages and Travels in the Interior of North America.
HEALY, W. J.—Women of Red River.
HEARNE, SAMUEL.—A Journey from Prince of Wales's Fort in Hudson's Bay to the Northern Ocean.
HENRY, ALEXANDER (d. 1814).—Henry's journal.
HENRY, ALEXANDER (1739-1824).—New Light on the early History of the Northwest.
HEWITT, CHARLES GORDON.—The Conservation of the Wild Life of Canada.
HODDER-WILLIAMS, RALPH.—Princess Patricia's Canadian Light Infantry, 1914-1919.
HOPKINS, JOHN CASTELL.—French Canada and the St. Lawrence.
KENNEDY, WILLIAM PAUL MCCLURE.—The Constitution of Canada.
KING, WILLIAM LYON MACKENZIE.—Industry and Humanity.
KIRKCONNELL, WATSON.—International Aspects of Unemployment.
LAUT, AGNES CHRISTINA.—The Conquest of the great Northwest.
LIVESAY, JOHN FREDERICK BLIGH.—Canada's Hundred Days.
LOCKE, GEORGE HERBERT.—Builders of the Canadian Commonwealth.
MACBETH, RODERICK GEORGE.—Policing the Plains.
MACDONALD, SIR JOHN.—Correspondence, ed. by Sir Joseph Pope.
MACKENZIE, ALEXANDER.—Voyages from Montreal through the Continent of North America to the Frozen and Pacific Oceans in 1789 and 1793.
MACMECHAN, ARCHIBALD MCKELLAR.—Sagas of the Sea.
MACOUN, JOHN.—Autobiography of John Macoun.
MAVOR, JAMES.—My Windows on the Street of the World.
MOODIE, SUSANNA.—Roughing it in the Bush.
OUTRAM, SIR JAMES.—In the Heart of the Canadian Rockies.
ROWELL, NEWTON WESLEY.—The British Empire and World Peace.
ROSS, ALEXANDER.—Adventures of the First Settlers on the Oregon or Columbia River.
SCOTT, FREDERICK GEORGE.—The Great War as I saw it.
SETON, ERNEST THOMPSON.—Life Histories of Northern Animals.
SKELTON, OSCAR DOUGLAS.—Life and Letters of Sir Wilfrid Laurier.
SNIDER, C. H. J.—The Glorious Shannon's old blue Duster.
STEFANSSON, VILHJALMUR.—The Friendly Arctic.
TYRRELL, JAMES WILLIAMS.—Across the Sub-Arctics of Canada.
WALLACE, WILLIAM STEWART.—By Star and Compass.
WILLISON, SIR JOHN STEPHEN.—Reminiscences: political and personal.
WILLSON, HENRY BECKLES.—The Great Company (1667-1871).
WOOD, WILLIAM CHARLES HENRY.—Fight for Canada.
WRONG, GEORGE MCKINNON.—The Fall of Canada.

Fiction

ALLAN, LUKE.—The Return of Blue Pete.
BARRINGTON, E.—The Ladies.

Baxter, Arthur Beverley—The Parts Men Play.
Beck, L. Adams.—The Perfume of the Rainbow.
Cody, H. A.—The King's Arrow.
Connor, Ralph.—The Man from Glengarry.
Cook, Marjorie Grant.—Another Way of Love.
De la Roche, Mazo.—Possession.
Duncan, Norman.—Doctor Luke of the Labrador.
Fraser, William A.—Mooswa.
Gibbon, J. M.—Hearts and Faces; Drums Afar.
Grenfell, W. T.—Northern Neighbors.
Hemon, Louis.—Maria Chapdelaine.
Hood, Robert Allison.—The Quest of Alistair.
King, Basil.—The High Heart.
Kirby, William.—The Golden Dog.
Leacock, Stephen.—Sunshine Sketches of a Little Town.
Macbeth, Madge.—The Patterson Limit.
Mackay, Isabel Ecclestone.—The Window-gazer.
Parker, Sir Gilbert.—The Seats of the Mighty; The Right of Way; Pierre and his People.
Paterson, Isabel.—The Magpie's Nest.
Pickthall, Marjorie.—Angels' Shoes.
Richardson, John.—Wacousta.
Roberts, Charles G. D.—The Prisoner of Mademoiselle.
Salverson, Laura Goodman.—The Viking Heart.
Scott, Duncan Campbell.—The Witching of Elspie.
Sime, Jessie Georgina.—Our Little Life.
Stead, Robert.—Neighbours.
Steele, Harwood.—Spirit-of-iron.
Sullivan, Alan.—The Rapids.
Thomson, E. W.—Old Man Savarin.
Wallace, Frederick William.—Salt Seas and Sailor Men.
Watson, Robert.—The Spoilers of the Valley.

History

Shortt, A. and Doughty, A. G.—Canada and its Provinces.
Steele, Harwood.—The Canadians in France, 1914-1918.
Tyrrell, J. B.—David Thompson's Narrative (Champlain Society).
Wrong, G. M. and Langton H. H.—The Chronicles of Canada.

THE FINE ARTS IN CANADA

Eric Brown, Esq.
National Gallery, Ottawa

All the pioneering in Canada has not been done on her plains and in her forests. The earliest representatives of the fine arts were the topographical draughtsmen and water colourists, most of them army officers stationed in Lower and Upper Canada. In our own day a vigorous and national school of painting is springing up, and art, at least as a child, walks in our midst. This movement has been no less heroic and deserving of epics and monuments than the work of the fellers of the forest or of the ploughmen of the plains. A slender chain of art galleries and art societies now exists all the way from the Atlantic to the Pacific. While the rich are collecting European old masters, the pioneering spirit is still present to the artist who neither teaches, nor paints portraits, nor designs for commercial purposes, but relies on a discerning public to permit him to dream his dreams and express in paint the truth that is in them.

Naturally a generation or two ago those who could buy pictures preferred the art of the old countries which they had left comparatively recently, while the art of their adopted land still held to the European tradition and produced little that was equally attractive. But this no longer holds good. In Canada landscape painting in particular and in a smaller way figure painting, sculpture, and even print-making have qualities, strong and original, and so vigorously characteristic of Canada and nowhere else, that every art lover and collector can say to himself: "here, at any rate, is the beginning of a school of painting as native and sincere as was the school of Crome and Constable in England a hundred years ago."

Hitherto this general appreciation has been withheld, and much criticism has been showered upon even the most temperate and rational advance along the lines of more brilliant colour and stronger design, which are influencing the whole of contemporary painting. For years exhibitions of Canadian art have been full of it. Since Canada is young and making a new path, traditions in art should not be expected to hold omnipotent sway. Only very slowly, however, does the Canadian collector turn from even inferior European productions to the art that is in our midst waiting for his help.

It has been said so often as to be a truism, but like most truisms it is very slightly appreciated, that there never was a great country which had not a great art. All the way through the ages, from Egypt to America, this is true. Not only so, but it can be discerned by any student that the greatest periods of a nation's history have been the periods of its highest art. Great art is not the product of degeneracy, either national or individual.

When Greece was developing her marvellous civilisation, Phidias, Praxiteles, Myron, Scopas, and others of its great company of painters and sculptors were born. When Italy was waking and striving for freer thought, learning, and good government, she produced the great artistic age of the Renaissance. Then, just as soon as her ideals decayed, and she degenerated, and was torn by internecine strife, her art decayed in the hands of a host of copyists. Spain tells the same story. Holland fought for freedom, as few countries have fought for it, and Rembrandt, Vermeer, and the great Dutch school were a part of the fruitage. England's greatest artistic periods were when she was resisting the reactionary aggression of Europe, in the sixteenth century, and laying the foundation of the greatest empire the world has ever seen, in the eighteenth and the early nineteenth. It must be so with Canada. History will care very little whether Canada develops even an overwhelmingly mighty materialism, but history will have reason to call her blessed if she develops a mighty civilisation of which art will be one of the most certain signs.

As much as Canada needs any one thing, she needs art in every possible form, art schools, art galleries, art associations, and sufficient art education in the public schools, at any rate, to familiarise the pupil with what is beautiful and useful, to the exclusion of what is hideous and useless. This programme of art expresses the life of the nation. It is not a mere aesthetic or cultural ideal. Few would deny the need of this lesser side of the advance, if one may judge our need by most of the objects with which we surround ourselves, and by the extraordinarily debased artistic ideas of the man in the street, eastern or western.

There is involved a vital economic question, the problem of commercial design. At present the great bulk of the commercial designs of all sorts, kinds, and conditions, comes to Canada from outside, though there is not the slightest reason why this should be so. The few Canadian commercial designers in Toronto and Montreal are proving that their work is quite equal to any emergency, and vastly superior to a large proportion of that which is imported. But we can count on the fingers of one hand, with some to spare, the art schools and other opportunities capable of turning a small army of would-be artists into

artistic designers of the thousand and one things we need, all the way from our clothes to our coinage.

The present method is in many ways grossly wasteful. Original design has to be paid for wherever procured. It might, therefore, be more economically paid for within Canada than without. It is even more wasteful of the youthful talent of the country, which tends to drift abroad, in order to find an outlet for its endeavours. When the manufacturer realises the importance of the art school to his factory, and adds his intelligence on the subject to the collector's, Canadian art will receive an impetus more prolific of results than can readily be imagined.

A great part of the work of the National Gallery during the past ten years has been to bring about such a condition and to further a desire for and understanding of art, which should form a basis for the growth in every community of any importance. That its efforts have met with some success, in spite of inadequate resources and of war conditions, gives cheerful prophecy for the future, when the momentum will have quickened and apathy and materialism may have been lessened.

There is practically no city or town of any size, from St. John to Victoria, which has not received at least one, and in most cases, a considerable number of loan exhibitions of art from the National Gallery at Ottawa. These exhibitions have been distributed at a minimum of cost to the communities. Though they have consisted occasionally of foreign pictures and prints, the effort has been mainly directed towards using Canadian productions, in order to give Canadians an elementary idea, at least, of the art of their own country. There is no doubt that solid results have been achieved. Very often such an exhibition has given a small community its first view of art of any merit, and a fairly long list could already be compiled of art societies, schools, and organisations which have arisen from this incentive. More recently, the exhibitions have been supplemented with lectures, either delivered on tour or written and supplied for local use, and a need is rapidly growing for a bureau of artistic information to carry on the fast increasing work in this direction. Often these exhibitions have been held in the public libraries, often in halls which some local society has undertaken to supervise. Occasionally the pictures are shown in such well known galleries as that of the Art Association of Montreal, the Art Gallery of Toronto, or the younger galleries at Hamilton, Winnipeg, and Vancouver. By far the greater number, however, have had more humble settings.

Now such exhibitions are beginning to be supplemented by the direct activities of the artists themselves, as the National Gallery

hoped they would. Groups, such as the Toronto Group of Seven, have sent several exhibitions travelling through the country. The Royal Canadian Academy organised an important one last year in Hamilton, and there are many cheerful evidences that, at any rate, the acute stage of artistic pioneering in Canada is passing into one more settled and permanent, if not for the moment unduly affluent. Affluence will come when the purchasing public realises that the greater part of imported art does not approach the native product in artistic significance.

The story of Canadian art and artists cannot be told within the limits of a single article, although it is not without romance. We know, for instance, Paul Kane's wanderings among the Indians, with the artistic results of his paintings of Indian life. We have Cornelius Kreighoff's inimitable pictures of the life of the early Quebec habitant. Interesting stories, too, are those of the later rise of the Canadian art societies in the 'seventies and 'eighties, such as the Ontario Society of Artists and the Royal Canadian Academy, and the establishment of such art institutions as the National Gallery and the others I have mentioned.

We are living in stirring times. The Canadian fine arts, too, are stirring, for which we may be devoutly thankful, for if they were not stirring they would be either dead or degenerate. Canada is to have her first opportunity this year of measuring her art against the other British Dominions at the British Empire Exhibition, and, whatever may be the relative standard attained by Canada, she will show that she possesses an indigenous and vigorous school of painting and sculpture, moulded by such things as the intense character of the country, and the colour of the seasons. This art is freeing itself from the trammels, though not from the ideals, of the European and older British traditions.

Nature possesses all the raw material from which the artist takes his schemes of colour and design. The artist manufactures for us and he invariably reflects the thought of his times. If he is great, he expresses the most advanced thought, if less great, the more conventional; but, great or small, he gives us something we cannot do without. Whatever disturbs us is good, since it sets us thinking and acting to prove it either worthy or wrong. We can hope that Canadian art will always disturb us, because there can be no surer proof of its inherent vitality.

A SURVEY OF MUSIC IN CANADA

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A German poet once launched the following paradox: "There is no art; there are only artists." A survey of music in Canada offers such difficulties that one is tempted to parody the above as follows: There is no Canadian music; but there are musicians living in Canada, and, to a lesser extent, Canadian musicians. That is to say that Canadian music as a national tone-speech, as a distinctive dialect, hardly as yet exists. Neither the creative artist nor the executant has drawn from the attributes of this country any distinctive traits sufficient to give him a national identity. Even the native music, that of the North American Indian and the Eskimo, is but a branch of that of the entire continent; and the folk songs, of which great numbers exist in the east, are often European songs which have survived transplantation. Yet the practice and study of music has increased very rapidly during the last two or three decades, and the quantity and quality of concerts together with the excellent educational facilities would, in certain centres, now bear comparison with the best that England or Europe generally affords.

Of the factors necessarily to be considered in attempting some appraisal of our musical status the following, in the writer's opinion, seem of the most importance. Firstly, as a well known writer, Mr. O. G. Sonneck, affirms, there is the negligible quantity of the rural population. Observers have suggested that cities of even 10,000 inhabitants may be classed, musically speaking, as rural. Indeed, it has been asserted that music as a noteworthy factor in social life does not make its appearance in a new country in cities with a population of less than 25,000 people. Of such cities we have in Canada, only 18.[1] Further, they are separated, taking the two extreme points, Halifax and Vancouver, by a distance of 3,624 miles. Added to this geographical separation is the demarkation caused by difference of race. Ontario knows little or nothing of the musical endeavours of Quebec, and Quebec, excepting at a meeting point in Montreal, is quite indifferent to the activities of Ontario, and, one might add, of the provinces

[1]Census of 1921. There are, however, 9 towns of between 20,000 and 25,000 inhabitants.

farther west. It will seem, therefore, that music is restricted generally to the efforts of a few centres, and that these centres are in many cases separated by vast distances, and, occasionally, by the incompatibility of races.

The second factor concerns the mental attitude of the population. A considerable portion of the inhabitants, even of the larger cities, is made up of people who are the descendants of pioneers. A distinguished Canadian affirms that this fact has resulted in a losing of the traditions of music and art.[2] The pioneers were of necessity deprived of an outlet for their musical proclivities. The next generation, lacking parental incentive, allowed any latent musical talent to lie dormant. Succeeding generations, with more leisure, have acquired a musical interest anew. But there is this difference: that their outlook is entirely untinged with classical reverence. It is only natural, therefore, that they often display some impatience with an art which is reflecting social conditions very alien to their own.

The next factor, unlike the two negative influences above mentioned, is of a more positive character. I should like to refer to this factor as British heredity. Its influence is apparent in many ways. Firstly, as in England, both musical enterprise and education have had to depend on private initiative and support. Federal, provincial, and civic governments have never shown any marked tendencies to regard music as a national asset.[3] Secondly, as in England, there is a decided predilection for choral singing—that most democratic form of music—and a corresponding coolness towards exotic influences such as that of the opera. The temperament which will impel a body of amateur singers to submit to months of severe drilling for the sake of a comparatively short hour of triumph is even more strongly developed here than in England. Indeed, it is in choral music that Canada has achieved her most noticeable successes, since it was the work of the Mendelssohn Choir of Toronto that first established the fact that Canada, musically speaking, could 'export' as well as 'import'. Further, the opinion has been strongly expressed by Americans that their own achievements in this particular way were inferior to those of their Canadian visitors. It may be interesting in this connexion to give the following details. The Mendelssohn Choir, founded and conducted for twenty years by Dr. A. S. Vogt and now conducted by Dr. H. A. Fricker, has visited the United States on eight occasions; a Canadian tour was undertaken in 1923; and only the outbreak of the war in 1914 prevented the accomplishment of a European tour which

[2]Sir Edmund Walker.

[3]It is true, however, that there has been civic recognition of artistic endeavour—in a few instances.

had been planned to include Scotland, England, Germany, and France. Another choir that has achieved success in this way is the Winnipeg Male Choir conducted by Mr. Hugh Ross. This body of singers, also, has visited some of the chief cities of the United States; further, their singing so excited the admiration of the English judges at the competitive festivals last year that a wish was openly expressed that the choir would visit England and sing at the Empire festival of this year. In connexion with these successes a point of interest which must not be overlooked is the inherent character of Canadian voices. While it would be impossible to single out as outstanding or peculiar any particular class, as for instance, the Russian bass, with his exceptional low notes, or the Welsh tenor, with his purity of tone, it is safe to assert that the voices, especially among the female singers, are of a very beautiful quality; also that, unlike in England, the real contralto voice shows no trend to absorption by the mezzo-soprano, but continues to be met with in surprising numbers.

Another important factor in the musical life of the country which, like the preceding, can claim British origin, is the competitive festival. The three prairie provinces have been leaders in the inauguration of this method of stimulating musical interest. Alberta held the first festival in 1907, Saskatchewan in 1909, and Manitoba in 1919. In all three provinces the movement has shown rapid growth. The Saskatoon festival of 1921 included fifty different competitions in which 1,500 to 1,700 competitors took part before large audiences. In 1922 Manitoba reported 64 classes and approximately 6,000 competitors. These figures will become more impressive to the English reader when he shall have realised the great distances to be covered and the difficulties of travelling. As the Ontario and British Columbia festivals were inaugurated only last year it is impossible to say whether the movement in these provinces is destined to meet with great success. The initial effort, in the case of Ontario, was a breaking of virgin soil, and the interest did not approach the intensity shown in the more westerly provinces.

Leaving such influences as may be traced to British origin there remains the output of instrumental music and solo music generally, the music in the churches, and the educational facilities for musical instruction. In the first of these the results so far obtained have not in every respect measured up to the standards obtained in choral singing. The establishing of first class symphony orchestras has so far met with only partial success. Prior to the war the Toronto Symphony Orchestra, conducted by Mr. Frank S. Welsman and supported generously by Mr. H. C. Cox, constituted a body of professional players that did much to promote a taste for and a knowledge of the

best orchestral literature. Last year a similar organisation was revived under the conductorship of Mr. Luigi von Kunitz, which during the last season has successfully carried out a series of twenty concerts. But in other cities, in Ottawa, Vancouver, Winnipeg, orchestras have consisted of an admixture of professionals and amateurs. Instrumental music, however, being beyond all question a rôle which the amateur cannot essay with the success that he achieves in other mediums, the results so far have attained only a local interest. An American influence very discernible in instrumental music is the Affiliated Union of Musicians. This is a protective union with headquarters in the United States, the Canadian 'Locals' being branches of the same corporate body. As a large majority of orchestral players are members of this union its influence has been very far-reaching.

Another important factor in the musical life of Canada which can be attributed to American example is the work of the numerous women's musical clubs. These exist in considerable number and, in some cases, they can point to many years of activity. Unquestionably the musical life of many districts has been the richer for their endeavours. A difficulty in musical life, which they to some extent mitigate, is the introduction of new artists, new mediums such as chamber music, and new works, to communities which would be unresponsive to the ordinary methods of advertising. In growing towns, the social life of which has been debarred from any serious musical interests, the promoting of concert work is usually a more hazardous undertaking—if the attraction is that of music *per se*. But an organisation with fixed membership, with certain social allurements, can and does pave the way for the first implanting of the germ of musical appreciation.

The music in the churches is generally of a high standard and the ability of choirs to sing *a capella* music is very evident. In many cases choir-training has been an excellent preliminary for larger choral work, and, likewise, many of the best choral societies can trace their inception to the successful beginnings in some particular church. Generally speaking the churches are more ready to permit their buildings to be used for concert work than is the case in England. This practice has been of a very great benefit, because the absence of town halls or other auditoriums suitable for concert work is, at present, one of the greatest obstacles to Canada's musical progress. The influence of the church is also seen in the industry of organ-building, many Canadian makers having achieved a high standard of excellence. One firm in particular, Casavant Frères of St. Hyacinthe, Quebec, has had the distinction of some notable installations in the United States.[4]

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[4]Casavant Frères are now building an organ in Paris, France.

Musical education in Canada naturally falls under three forms of instruction: private, in the public schools, and in the musical colleges. It is apparent that in all three ways there has been a most marked increase and improvement during the last two decades. In the most important musical centres there are teachers who have received the best European training, and the necessity for Canadians to undergo now a course of study in European capitals seems to be lessening. The colleges, in many cases, do not conform to the European practice of taking only full-time students. There is not, generally speaking, the element of discipline that most of the old world conservatories demand, and consequently, a number of older musicians still incline to the opinion that the training given here has not the broadness that is to be had, say, in London, Paris, or Germany. On the other hand the teachers here, confronted with the problem of instructing what may be described as a freer and more self-willed element, are rapidly grappling with the psychological problems of teaching and are evolving methods which sometimes are a little less arbitrary and despotic than those of the older lands. The largest college, perhaps in the entire British empire, is that known as the Toronto Conservatory of Music. It is now part of the University of Toronto and is governed by a principal and board of governors who are responsible to the university. The registration of students during recent years runs into thousands. An extensive system of examination has been established, with centres extending from Ottawa to Victoria; in addition a few have been opened in the United States. The examination of the summer of 1922 disclosed a list of 10,500 candidates.

In conclusion it may be pointed out that the music of Canada is essentially "in the making", in marked contradistinction to that of certain European countries the musical life of which is "in fullest capacity". It is to be noted, also, that a survey of an art in process of construction is always a more difficult task than a review of one that has "arrived". Nevertheless, the following points may be reiterated: (1) that chorally Canada is in the first rank; (2) that the standard of pianoforte playing and in a lesser degree of violin playing has made very remarkable advances during the last two decades; (3) that in centres like Toronto there are excellent educational facilities; (4) that in the middle and far west there is almost a feverish anxiety to acquire certain kinds of musical instruction, and that such instruction is undoubtedly, though perhaps unconsciously, performing that great essential—the laying of a foundation.

CANADA'S NATIONAL PARKS

J. B. Harkin
Commissioner of Canadian National Parks

Canada has a very extensive system of national parks, aggregating a total area of nearly 10,000 square miles. This great area—larger than the principality of Wales, nearly twice the size of the county of York and one-third the extent of Scotland—comprising fourteen reservations and some of the most remarkable scenic regions in the Dominion, has been set aside by the federal government for the "perpetual use, benefit, and enjoyment of the people." It constitutes an important recognition on the part of the government of the great principle which is coming each year to be more and more widely recognised, not only on the North American continent but throughout the civilised world—the principle of the right to national ownership of natural scenery of unique attraction. These great reservations form too, in Canada, an interesting expression of the developing sense of national consciousness and are an evidence of her instinctive but growing "love of the land".

The largest of these national reservations—Jasper national park in the northern Rockies—covers 4,400 square miles or an area approximately equal to that of the counties of Surrey, Suffolk, Middlesex, Gloucester, and Warwickshire combined. The use of the term "park" in connexion with such vast territory must seem incongruous to anyone familiar only with the parks of older countries, where the word usually denotes a reserve of formal and ordered beauty limited in extent. On the North American continent, however, the term "National Park," inadequate though it is felt to be, has come to have a special and clearly recognised significance; this in spite of the fact that it is used to cover several kinds of reservations. In its broadest meaning a national park is a public reservation of land which for one reason or another is of common national interest. Such reserves vary in Canada from great regions, characterised by outstanding scenic beauty or unique phenomena of nature, to small areas preserving sites memorable in national history or bearing remains of aboriginal occupation.

Origin of Movement.—The national parks movement had its origin on this continent and may be said to be a logical development of the general movement for the conservation of natural resources.

In adding up the national assets it became clear that exceptional scenery must be taken into account, not only because it has the power of enriching and increasing the life of the people, but also because it can be made to augment the economic wealth of the country. It was clear, too, that this form of wealth was as much in need of protection as many other resources; that the earth and the riches thereof could be thoughtlessly squandered quite as readily in the case of natural beauty as in the case of timber or minerals or other resources of the land.

With the advance of commercialism and the increasing power of wealth there has been, it is only too true, in all lands, ruthless destruction of priceless beauty or alienation of scenic glories from the enjoyment of the people.

"This first day of May," wrote Ruskin, from Switzerland, in 1869, "I am writing where my work was begun 35 years ago, within sight of the snows of the higher Alps. In that half of the permitted life of man I have seen strange evil brought upon every scene that I best loved, or tried to make beloved by others. The light which once flushed these pale summits with its rose at dawn, and purple at sunset, is now ambered and faint; the air which once inlaid the clefts of all their golden crags with azure is now defiled with languid coils of smoke, belched from worse than volcanic fires; their very glacier waves are ebbing and their snows fading, as if Hell had breathed upon them."

All these considerations gave grounds for alarm and suggested the necessity for taking steps towards the formation of a policy of conservation.

The special form that the movement has taken in Canada is due to the Canadian spirit, a spirit as yet perhaps only dimly recognised by Canadians themselves. It is a spirit vague and inarticulate but reaching out in such efforts as the national parks movement for clearer expression. To understand it one must remember that love of country in Canada is not based, as in older lands, upon the settled peace of the country-side with its quiet beauty of copse and garden and farm. It is a love born in the breasts of those adventurous spirits who came first and conquered the wilderness—a love of the primitive, the untamed, and the wild. In their struggles to make a home in this new country the forefathers of present-day Canadians had to conquer the wilderness and they came at length not only to lose their fear of the wilderness but to love it with a deep though usually unsuspected passion that has been transmitted to their sons. The swift onrush of settlement in the last half century has been pushing the wilderness farther and farther back, changing the face of primitive nature, sweeping out of sight much of the virginal beauty that once characterised the

whole land. The great forests, the untainted rivers, the rich heritage of wild life of all kinds—these tend everywhere to disappear. To preserve out of its vast area, for the generations to come, a certain share of primitive nature is the meaning of the national parks movement. These great reservations exist to preserve examples of the original Canada, the Canada that existed for hundreds of years before man be-

Fig. 7. MOTOR ROAD, MORAINE LAKE, BANFF NATIONAL PARK

gan to destroy its natural beauties. Everywhere else, it is recognised, nature must gradually but inevitably give way to the economic pressure of civilisation, but in the national parks at least, primitive beauty may remain untouched and unscarred by the hand of man. The parks it may be said are the sanctuaries of the original and the wild.

Development.—The development of the national parks movement has been a gradual growth covering a period of approximately two score years.

Canada's first national park, Rocky Mountains park, of which Banff is the centre, was established in 1886 almost immediately following the completion of the Canadian Pacific Railway across the continent. The construction of the line through the Rocky mountains opened up to Canada and to the world an area of such wondrous beauty and grandeur that practically everyone who saw it declared it should be preserved intact for the enjoyment of future generations. Action was promptly taken by the Canadian parliament and in 1885 the first reservation was set aside in the vicinity of Banff. This was followed the next year by other reservations in the neighbourhood of Lake Louise, Field, and in the heart of the Selkirks.

Later the Banff reservation was so enlarged as to include the Lake Louise region and the other two reservations became known respectively as Yoho and Glacier parks.

At the outset the main impulse was to set these areas aside; to mark them as public possessions. What specific purposes the parks could serve, what ideals should mould them, what policy should be adopted for development—these objectives were only dimly understood. The policy has had to be gradually evolved. Switzerland years before had demonstrated that mountain areas of supreme beauty were a distinct commercial asset and from the outset this aspect was kept in view. While those who are associated with the work have long since ceased to regard the commercial side as the most important consideration they have never disregarded the part it plays.

Tourist traffic is sufficiently important to make the national parks an economic factor in the prosperity of the country and to give them a rightful place in any list of natural resources.

Other Objectives.—While such additions to the prosperity of the country are of great importance, there are other aspects of the parks which have come to be considered of equal if not greater value to Canadians themselves. The recognition of these values has been a gradual growth, developing with the use of the parks themselves. For many years the government was content with having set the areas aside and with having marked them as public possessions. Later, as the fame of the Rockies grew and visitors began each year

to increase in number, developments in the way of roads and trails and provision of various public utilities were found necessary. The hot springs at Banff became noted for their therapeutic qualities and a small town grew up in the Bow valley. Adventurous spirits were each year penetrating farther into the mountain wilderness and coming back with stories of wonderful peaks and alpine glories beyond. To meet the demands of those who wished to follow them, trails had to be built. The penetration of the forests by travellers brought, too, a new danger—the danger of forest fires—and an adequate and comprehensive fire protection service patrolling the whole area became necessary. Gradually other reservations were added as new regions were opened up, notably Waterton Lakes park in southern Alberta, a delightful though small reserve of 226 square miles adjoining the international boundary, and Jasper national park, a huge reservation in the northern Rockies in the country opened up by the construction of the Grand Trunk Pacific Railway.

Wild Life.—About 1910 it was brought to the attention of the government that the big game of the parks was suffering as a result of steady encroachments on the part of Indians and others and that its disappearance was threatened. The parks had been nominally wild life sanctuaries since their inception but no adequate provision for the enforcement of game regulations had been made. With surprise and concern it was realised that the Bighorn sheep (*Ovis Canadensis*), the most interesting native animal of the Rockies, and the wild goat (*Oreamnos montanus*), once numerous in these regions, were being steadily exterminated. Even the trails built for the convenience of tourists and for forest protection had contributed to the ease with which they could be attacked. A national park, however, from which either the original fauna or flora had disappeared, it was realised, would be no national park at all. A complete system of patrols and inspections was consequently established with surprisingly successful results. Within less than two years the wild life began to come back and its original numbers have gradually been restored. Nowhere perhaps has the value of the sanctuary in the conservation of wild life been more clearly demonstrated than in the national parks. These reserves throughout Canada form breeding places for all kinds of wild life, which is now beginning to spread beyond their borders and to stock the surrounding districts. The absence of persecution or violence of any kind has also freed the animals from the fear of man and they are becoming noticeably tamer each season. Deer and even bear come within a few yards of human habitation and readily allow themselves to be fed while Bighorn sheep will permit visitors to come within camera range. Wild life is perennially interest-

ing and the pleasure of being able to establish such close contact with beautiful wild creatures and to have the opportunity of photographing or studying different species in their native haunts has now become one of the great attractions of the parks. For an increasing number it is proving more satisfying than the instinct for the chase.

National Museums.—The national parks of Canada are thus coming to be national museums of primitive America, and as such their importance from the educational point of view steadily increases. For the student of science in many branches, they afford unequalled opportunities for study, and each year they are being more widely used in this respect. They conserve exhibits of our various land forms, our waters, and the wild life of every kind which they support under absolutely natural conditions and in natural descent. Each year it is growing clearer that the most complete conservation of these values is of great importance to science and to education in the future, when primitive conditions may exist no more. Already the parks are proving a valuable adjunct to education and are becoming, more and more, fields for scientific study and exploration. The American Association for the Advancement of Science last spring passed a resolution asking the governments of Canada and the United States to develop their two national park systems as one, in the interests of science and popular education, and to preserve the integrity of the parks for all time. The Royal Society of Canada passed similar resolutions.

Recreation.—The purpose of the national parks that appeals most to the general public is to provide large areas of magnificent natural scenery as a refuge from the pressure of modern business life, a way of escape into regions of natural beauty for the renewal of bodily strength, for the recreation of spiritual power, and the re-awakening of those spiritual interests which have so much to do with the sustained happiness and energy of life.

The impulse to escape from the crowded city into great open regions, to camp among the mountains or amid the quiet restfulness of the forest or beside some beautiful lake or stream is sending increasing thousands each year to the national parks. Whether they are sought for aesthetic, educational, or recreative reasons, the parks are serving a national need. Those who are in charge of the national parks have come to see that it is a mistaken notion that only the comparatively few cultured and highly educated people have aesthetic appreciation of these places of great natural beauty. It is realised that aesthetic appreciation is a natural instinct and a very democratic possession.

Everywhere it is being admitted that provision for this impulse is the finest economic wisdom and this provision demands the con-

FIG. 8. BEAUVERT LAKE AND PYRAMID MOUNTAIN, JASPER NATIONAL PARK

servation of the nation's scenic glories as not only the cheapest but the most obviously successful and satisfying means of meeting this need. In other departments of national life great expenditures have to be made to meet developmental needs and the progressive thought of the nation—schools, bridges, railways, buildings, factories, and commercial institutions—but in the building up of national parks, Nature has done so much that all that man needs to do is to preserve her creations and make them available for the widest and most democratic use, to carve new ways of access to the glory that has been given him and to minister to the convenience and pleasure of those who are wise enough to find rest and recreation among the wonders of creation.

Animal Parks.—Out of the impulse to preserve examples of original conditions have grown as a natural consequence the special animal parks which exist for the protection of nearly extinct native animals such as buffalo, elk, and antelope. All national parks wherever they are found are wild-life sanctuaries but the seven great scenic reservations in the Rockies need only adequate patrols to achieve their ends. There is no surrounding settlement to complicate the situation.

But the buffalo and antelope have their habitat on the prairie, and the prairie is now almost entirely settled, so that the home of these species has disappeared. To afford them protection it was necessary to create large fenced enclosures in which they could thrive and propagate under natural conditions without encroaching on the land of settlers. At Buffalo park, Wainwright, Alta., within an extensive fenced enclosure of 160 square miles, may be seen a large herd of buffalo living under conditions practically identical with those enjoyed by the species when the white man first invaded their feeding grounds. From the original stock of 700 obtained sixteen years ago there is now a herd of over 8,000, and surplus stock is being utilised for buffalo meat and robes, which have been placed on the market. Successful operations have also been carried out in cross-breeding the buffalo with domestic cattle with a view to producing a new type of animal which will be adapted to the severe winters of the far north.

A smaller park known as Elk Island park, containing buffalo and elk, lies within a couple of hours motor ride from Edmonton, on the Canadian National line.

In Southern Alberta and Saskatchewan there are also three reserves for the protection of antelope, the most important of which is at Nemiskam, Alberta.

Bird Life.—Recently, too, steps have been taken to preserve bird life, the reduction of whose numbers had been the cause of serious economic loss. Point Pelee park, in southern Ontario, was set aside because it is a natural resting place for hundreds of species on the long

migrations from north to south and return. It is hoped it will afford protection to many kinds of both insectivorous and game birds. Other reserves protecting the breeding grounds, especially of wild fowl, practically all of which breed in Canada, are also being set aside.

Historic and Prehistoric Sites.—It is but a step from the preservation of primitive nature to the preservation of sites connected with national history. Both serve an educational purpose and help to develop love of country. Within the past few years the Canadian National Parks Branch has been making a survey of all sites where events of national importance have taken place. Some of these, like old Fort Anne, Annapolis Royal, N.S., have been set aside as national parks. In other cases where less land is available the sites are being taken over and suitably marked and preserved. A survey of prehistoric remains and of some of the interesting culture of aboriginal occupation, such as the totem-pole art of the West Coast Indians, is also being made and steps taken for their preservation where possible.

Location and Number.—There are at present fourteen national reservations administered as national parks. Seven of these are in the Rocky and Selkirk mountains, four of them along the main line of the Canadian Pacific Railway: Banff, Yoho, Glacier, and Revelstoke parks. Jasper park is in the northern Rockies reached by the Canadian National Railways, Kootenay park lies along the new motor highway across the Rockies from Banff to the Columbia valley and Waterton Lakes park in southern Alberta adjoins the United States boundary. These seven reservations present practically every type of scenery found in the Rocky and Selkirk ranges.

The Canadian cordilleras, as is well known, comprise three great parallel belts each of which includes several mountain systems, and which together make up a mountain area that covers, roughly speaking, about 250,000 square miles. The Rockies system is the greatest both in area and in the height of its peaks. It extends from the eastern foothills west to what is known as the Rocky Mountain trench, the great intramontane trough that marks the division between the older mountains to the west and their more youthful descendants, the Rockies. The Selkirks lie within the loop formed by the great bend of the Columbia river which, rising in the Kootenay lakes, flows north not far from the Athabaska pass and then, making a wide detour, flows south to the international boundary.

Each of these great reservations has a distinct individuality of its own, for while there is a general resemblance throughout all parts of the Canadian cordilleras, each range and section has its special characteristics and charms of scenery that differentiate it from any other. In the Rocky Mountain range the peaks are for the most part of grey

FIG. 9. KOOTENAY RIVER NEAR MACLEOD MEADOWS, KOOTENAY NATIONAL PARK

limestones with bands of purplish shales, and their summits have been worn in many cases into sharp spires, pinnacles, and castellated effects. The Selkirks show the marks of their much greater age, and though probably once the higher range, they are now from 1,000 to 2,000 feet lower than their more youthful neighbours. In the Rocky Mountain range too there is a much lighter precipitation, and Chinook winds remove much snow from the eastern slope that would otherwise go to form glaciers, so that their grey, sharp-pointed peaks often rise gaunt and bare several thousand feet above timber line. On the loftier peaks, however, beautiful glaciers and permanent snowcaps are to be found, while in the Lake Louise region and elsewhere along the divide every charm of the true alpine world may be found. Characteristic of the Rockies, too, is the countless number of beautiful lakes with an infinite variety of colouring and setting that holds the spectator almost breathless. The forests of the Rockies while always beautifully green, are lighter in colour and less dense in undergrowth than those farther west.

In the Selkirks precipitation is extremely heavy, the average being 56.68 inches of which more than 75 per cent. falls as snow. This great mass melts but little from year to year and forms a thick cap reaching down often to timber line. Glaciers are found in great abundance. The Selkirks, too, are pre-eminent in the wonderful luxuriance of their dark green forests, rich undergrowth, and the variety and beauty of their wild flowers.

In the east there are two reservations for public recreation under federal control: Point Pelee park in southern Ontario and another among the Thousand Islands of the St. Lawrence river. The provinces of Quebec, Ontario, and British Columbia have, also, important and beautiful reservations set aside as provincial parks.

All these are conserving for the future outstanding regions of natural beauty and places of national interest and ensuring that Canadians will have access to them for all time. They constitute inalienable national possessions of which a country may be justly and humbly proud as it would be of great national works of art. Their value to the nation grows every year clearer and more important. Not only do they add to the economic wealth of the country but they are serving as well to meet the aesthetic, educational, and recreative needs of the people and to enrich the common life. In unsuspected ways, too, they are deepening the national consciousness and the Canadian's love for his land, for it is very true that "it is the love of country that lights and keeps glowing the holy fire of patriotism and this love is excited primarily by the beauty of the country."[1]

[1]For bibliography see appendix.

THE CLIMATE OF CANADA

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Canada, the northern half of the continent of North America, stretching from Atlantic to Pacific and from the United States boundary to the Arctic sea, covers an enormous territory, most varied in latitude, in altitude, in distance from the sea, and in topographical features. It follows then, quite naturally, that climatic conditions are very varied; and as lofty mountain ranges parallel the Pacific coast at no great distance from it, it follows also that the continental type of climate predominates, and it is only the immediate coast line of British Columbia that possesses a climate of the marine type such as that of northwestern Europe.

The most southerly point of the Dominion is Pelee island in latitude 41° 40′, corresponding to that of Rome, Italy, while lands with some undoubted agricultural possibilities exist in the valley of the Mackenzie river, near the Arctic Circle. The foothill lands of southern Alberta are at an altitude exceeding 3,000 and even 3,500 feet, and these elevations fall away northward to 1,000 feet in the lower reaches of the Peace river, and eastward to 2,000 in eastern Saskatchewan and to less than 1,000 in eastern Manitoba. The western prairie lands are far removed from any direct tempering influence of the ocean, while mountains in the west, and great inland lakes in the east, play important rôles in modifying climatic conditions.

British Columbia.—The province spreading over 11° of latitude, with an average width of 700 miles and some districts of high elevation, has, within its own limits, climates which differ greatly. The littoral is mild and humid, while the interior plateaus between the mountain ranges, distant from the coast and at a higher altitude, have colder and drier winters.

Vancouver island in the Pacific ocean occupies somewhat the same position in relation to the American continent that Great Britain in the Atlantic does to Europe, lying between nearly the same parallels of latitude. The climate, as in all other parts of British Columbia, varies much with the orographical features of the country. The annual rainfall along the exposed western coast of the island is very great, generally exceeding 100 inches, but in the more easterly districts it is

less than half that amount. A comparatively dry period extends from May to September, while copious rains fall between September and March. The mean monthly and mean annual temperatures correspond very closely with those of England, the summers are quite as long, and severe frosts scarcely ever occur.

On what is usually termed the lower mainland of British Columbia, the climate is everywhere equable and mild. The lower Fraser valley in its northward stretch to its junction with the Thompson river traverses latitudes corresponding to the southern half of England. The spring opens early, the summers are warm, and the winters, which are mild and rainy near the coast, increase somewhat in severity with increasing distance from the sea.

The change in climate between the west and the east sides of the Coast range is decidedly abrupt. The Pacific winds are deprived of much of their moisture in ascending the western slopes of the mountains, and the air flows eastward or is drawn down to lower levels and becomes drier and warmer. Hence the interior plateaus between the coast and the Selkirk ranges possess a relatively dry climate. The summers are warmer and the winters are colder than on the lower mainland. The cold of winter, however, is seldom severe, and the hottest days are rendered pleasant by the fact that the air is dry and the nights are cool. In all the lower levels of British Columbia, March is distinctly a spring month. In the more southerly divisions, the mean temperature of April corresponds very closely with that of the same month in England, while the summer may very well be compared with that of southern Ontario, except that the air is much drier and the rainfall is scant. This is a fine fruit-growing country, and, even in the higher reaches, orchards and vineyards yield large crops.

In the more northerly districts of the province the climate near the coast is distinctly wet but mild. Observations at Prince Rupert show an annual precipitation of 100 inches, an average January temperature of 32° F, and in July of 57°, not unlike the record of parts of Scotland.

In the interior plateaus, very generally at an altitude exceeding 3,000 feet, the climate becomes more severe with higher latitudes and increasing distance from the coast, but large areas are suitable for mixed farming and ranching.

Alberta.—It is doubtful whether there is any other territory on the surface of the globe with a winter climate as variable as that of this province. The normal winter is cold and in some years extreme cold is continuous from November to March, but in other years the Chinook wind is most persistent and warm days with bright sunshine are the characteristic features of the winter; *e.g.*, the mean temperature of November 1890 at Calgary was 39°, the mean of November 1896

was 2°, the mean of January 1906 was −6°, while the mean of January of the following year was 26°. Corresponding variations occur in all parts of the province.

An average daily maximum of 53° at Calgary, 53° at Edmonton, and 58° at Medicine Hat indicates very clearly that April is truly a spring month, and verifies the statement that spring seeding is well under way or perhaps completed in April. The rapid upward trend of the temperature curve continues during May and June, and from the middle of May until the end of July occurs the heaviest rainfall of the year, a rainfall which is, on the average, nearly equal to that of Ontario and Quebec during the same period, but which varies much from year to year.

Bright hot days may be confidently looked for during July and August and very occasionally in these months temperatures exceeding 90°, sometimes nearly 100°, are recorded, but the average mean maxima of 82° at Medicine Hat, 75° at Calgary, and 73° at Edmonton indicate a not unpleasant warmth while the corresponding minima show that the nights are pleasantly cool. An important fact in connexion with the climatology of Alberta is that the isotherms during the summer months run nearly north and south and the mean summer temperature is almost as high in the extreme north as in the south.

Fort Dunvegan in the Peace River country and Fort Chipewyan on Lake Athabasca have nearly the same mean summer temperature as Calgary and Edmonton, and with the longer period of sunlight it is probable that plant life in the north may make more rapid growth than in southern districts. While the summer is of a pretty uniform character throughout the province, the effect of the latitude is shown before the end of August by the more rapidly diminishing temperature at northern stations. We find the following winter, December to March, mean temperatures: Calgary 19°, Edmonton 16°, Fort Dunvegan 1°, and Fort Chipewyan 1° below zero.

The Chinook wind is one of the characteristic features of the climate of Alberta and usually occurs with strong southwest and west winds. It is most frequent in the south, but is by no means uncommon even in the Peace River country. Sometimes a change of wind from north and northeast to southwest, will, in Alberta, mean a rise of temperature from perhaps 20° below zero to 40° above in a few hours. Largely to the effect of this wind is due the fact that the prairies of southern Alberta are usually bare of snow during the greater part of the winter.

Saskatchewan.—The southern half of this province is almost wholly prairie land, and it is only to the northward of the Saskatchewan river that any extensive forest areas are found. The climate is very similar

to that of Manitoba, except that in the southwestern portion spring sets in somewhat earlier than in the north and east, and in mid-winter the Chinook effect of the mountains extends at times even as far east as Regina. Up to the end of April the temperature of southern Saskatchewan is somewhat higher than that of Manitoba, but from May onward through the summer it is a little lower and remains so till December. The mean daily range of temperature during the summer months is here, as in other prairie provinces, very large amounting to between 25° and 28°. Occasionally during both early June and the latter half of August the temperature goes dangerously near the freezing point, and there are several instances on record of considerable damage by frost to unripened crops. The mean total annual precipitation is from 15 to 18 inches, of which amount nearly 60 per cent. falls in the growing season, May-August. The snowfall is from 30 to 35 inches in western and southern districts and from 10 to 15 inches greater in the east and north.

Manitoba.—The Province of Manitoba is almost in the centre of the continent, about mid-way between the Atlantic and Pacific oceans, and also mid-way between the Gulf of Mexico and the Arctic sea. It is many hundreds of miles distant from any high mountains and there are no important water areas to the westward. The topographical features of the province are not pronounced. About two-thirds of the total area, including the basins of Lakes Winnipeg and Manitoba, are at a level of less than one thousand feet, while to the westward the levels increase gradually to about sixteen hundred feet, with some few districts a little higher.

Such being, in brief, an outline of the geographical and topographical features of the province, it is not surprising that the climate is typically continental in its character and that such differences as exist between different districts are due chiefly to latitude and the general meteorology of the zone in which the territory lies.

The very pronounced contrast between the continental and littoral type of climate is well evidenced by the fact that the mean range in temperature between the warmest and the coldest months of the year is 70° at Winnipeg, while it is but 21° at Victoria, B.C. The absolute recorded range of temperature at Winnipeg is 153°. A change of temperature of 40° in 24 hours is not very exceptional in winter in Manitoba, and a range of 49° has been registered. Very pronounced, also, are the departures from the normal in corresponding months in different years, there being a January record with the mean temperature 8° above normal, and a February with a mean temperature 25° above normal, and also one with the mean 13° below normal. The monthly variations from normal are not so pronounced in summer, the

mean temperature of the warmest July having been 70.2° and of the coldest 60.6°.

As will be obvious from the figures just given the change from winter to spring is more rapid than in Great Britain or western Europe, and frequently April, which is wintry at the beginning, ends with conditions approaching those of summer. An average April is not so warm in Manitoba as it is in England. The season is not, however, so backward as the mean monthly temperature might seem to indicate. The daily range is large, approximately 25°, and, while the nights are cold, the day temperatures are high; the frost soon leaves the ground, and the farmer may commence sowing. The mean temperature of May is as high as in the south of England, with the mean maximum considerably higher, and while frosts occasionally occur, they are seldom severe. Light snowfalls, also, occur in this month, and at times are accompanied by high winds, but these storms are seldom injurious to agriculture.

The rapid upward trend of the temperature curve continues during June, the average daily maximum of which month is 74° at Winnipeg, and 72° at Minnedosa. Warm days with frequent showers produce an almost phenomenally rapid growth, which continues through July, for which month the mean temperature at Winnipeg is 66° with an average daily maximum of 78°. Few summers go by without several heat spells, during which the temperature rises to 90° or over, and in August 1886, 103° was recorded in Winnipeg and 104° in the more westerly districts.

August shows a declining mean temperature after the middle of the month, and the last fortnight is a period of uneasiness among farmers, as it is known that in some years slight frosts have occurred, injuring such crops as were not yet fully ripe. Summer is, however, by no means over, and periods of exceptionally warm weather are not infrequent even in September; it is only occasionally that there are night frosts in that month. October is the true autumn month, during which the temperature curve begins its most rapid decline; and, before its close, severe frosts are of nightly occurrence, and on some days the temperature may not rise above the freezing point.

The winter may be regarded as lasting for five months, from November to the end of March. It is not usually, however, until the last week in November that the temperature falls to zero, and this occurs on a few days only, and it is seldom that zero is registered after March 25th.

At Winnipeg the greatest annual precipitation recorded was 29.24 inches in 1878, and the least 14.38 inches in 1886, in which year only 4.23 inches fell during the May to August period. Most of the summer

rainfall occurs in thunderstorms, which at times are quite heavy, accompanied by violent squalls and, less frequently, by hail. It is but very seldom that these storms attain the energy of the tornado, which is not uncommon on the more heated prairies to the south.

The snowfall of Manitoba ranges from 52 inches in the eastern districts to 44 inches in the western districts, and while the ground is usually well covered from December to March, it is seldom that the depth is great. In most winters there are several heavy northwest gales succeeding the passage of cyclonic areas, and in these storms, as the temperature drops quickly accompanied by a blinding drift of the dry snow, we have the well-known blizzard of the prairies.

Ontario.—The Province of Ontario, alone, is a vast territory, stretching over 15 degrees of latitude from a point in latitude 42° to a point in the same parallel as the north of Scotland, and in breadth including twenty degrees of longitude. The almost entire north and east shores of the Great Lakes belong to Ontario, and her lands form about half the west shore line of Hudson bay. In portions of Ontario the climate is tempered by lake influence. Other portions are affected by the northern inland sea, and still others are exposed to the severe cold waves from the far northwest which in winter sweep with unchecked severity over the country north of Lakes Superior and Huron. Altitude, too, is responsible for some climatic variation, the country rising away from the various lake levels to heights which reach 1,800 feet just south of the Georgian bay, and over 1,500 feet near the upper Ottawa river.

The climate of the peninsula of Ontario is much warmer than that of the northern parts of the province. It is true that the first part of March is usually rather cold, but bright sunshiny days and swelling buds, together with the rapid disappearance of the snow which now lies only in sheltered places, give omen of spring, which soon comes on apace. Light snowfalls occasionally occur in April but this month with a mean temperature of about 43°, 3 inches of rain, and 190 hours of bright sunshine, is truly spring, and before the close of the month wild flowers are in bloom and the trees are leafing out.

With a high percentage of bright sunshine and ample rain, vegetation makes rapid progress during May. Frosts are quite infrequent, and by about the 24th of the month most of the trees are in full leaf.

The summers, while warm, are not oppressively so, the mean temperature of July, at the more southern stations, being but a shade above 70°, and a few degrees lower in June and August. Wholly overcast and rainy days are of rare occurrence, the rain falling in showers and thunderstorms of short duration; indeed from the middle of June until the end of August we may expect no day without a few

sunny hours. The autumn sets in very gradually, and while frost may sometimes occur as early as September 20, it is usually well on in October before there is anything severe, and towards the end of November before the mean daily temperature falls to the freezing point.

Northward and eastward from Lake Ontario to the Ottawa valley the spring opens somewhat later than in the south, but from mid-April until the end of August, the temperature and rainfall are much the same as in the southern parts of the province, modified in certain districts by the effect of higher altitude, and in others by lying to the eastward of and in close proximity to the Great Lakes. September, however, shows a more rapid downward trend of temperature. Killing frosts occur at an earlier date and the whole northern country is usually covered with snow before the close of November, while all the southern counties are still bare.

In the north the mean temperature of the three winter months is fully ten degrees lower than in the south, but, during March and April, the temperature curves rapidly converge. The lowest temperature of which there is record at Ottawa is −33°; at Toronto the lowest is −26°, while at London it is −25°. Yet at the southern stations such extremes are very rare, while at northern stations they are of not infrequent occurrence.

That portion of the Province of Ontario north of and immediately south of the main line of Canadian Pacific Railway, sometimes called New Ontario, lies between Lakes Superior and Huron and Hudson bay, and includes the major portion of the province. The region is as yet sparsely settled, and but few meteorological observations have been taken. There are, however, sufficient data to show that the whole region has very cold winters which increase in severity with the increasing latitude, and indeed in Patricia the winter type is distinctly sub-arctic. In the more southerly parts of this region, except near Lake Superior, the spring is well in evidence in April, and by the first of June the trees are in full leaf. Northward, towards James bay, the opening of spring is later with a probability of frosts in June, but the summer is fairly warm even near James bay with frequent temperatures of 80° and occasional readings of 90° and over.

Near Lakes Nipissing and Timiskaming, the rainfall of the growing season, May-August, is nearly 13 inches, very similar to that in southern Ontario, but northward this gradually diminishes, until at Moose Factory it is about 10 inches, and at Fort Hope 8 inches. The winter snowfall is between 80 and 100 inches. With practically no thaws, snow gradually accumulates as the winter passes.

Quebec.—The Province of Quebec, like Ontario, covers an immense area, between 22 degrees of longitude, and extending from latitude

45° to the barren lands on the shores of Hudson strait. The southwestern districts of the province, which are the warmest, are not, as in the Ontario peninsula, protected by the Great Lakes, and hence the winters are considerably colder, and the autumnal frosts occur a little earlier. Perhaps the most striking feature of the Montreal climate is the rapidity of the advance of spring. March is essentially a winter month, but April is on the mean nearly as warm as in Toronto, the May normal is higher and the summer months are all slightly warmer than in Toronto. The September and October normals are both quite similar to the corresponding figures for southwestern Ontario, but in November the thermometer shows a more rapid downward trend, and then follows a winter with a normal temperature 10° lower than in Toronto. For four months the ground is usually covered with a depth of between one and three feet of snow. Eastward in the St. Lawrence valley the summers are cooler and the winters decidedly colder, and with the retardation of the opening of spring, consequent upon a higher latitude and the more gradual melting of a snow covering, it is not until May that the leafing of the trees is at all rapid; mid-September, too, usually sees the brilliant autumnal colouration of the foliage.

Northwestern Quebec or that part of the province which lies between the 47th and 51st parallels and west of Lake St. John is a territory almost wholly lacking meteorological stations, but observations in Ontario, at Haileybury, Abitibi, and Moose Factory indicate very closely the climatic conditions from south to north over this large district. The winters setting in towards the end of November are decidedly cold, with a heavy snowfall, and it is usually well on in April or early May before the woods are entirely free of snow. The summers are distinctly warm as indicated by the high average maximum of 74.5° at Haileybury in the south and of 69.8° at Abitibi in the north, and few seasons pass without some heat spells, when 90° and over are recorded. As in New Ontario, early June frosts would appear to be a most serious detriment to agriculture, but as yet it is not known conclusively how often these occur. September is autumn and frosts are quite probable about the middle of the month. Both summer rain and winter snowfall are greater than in the corresponding Ontario zone and both gradually diminish northward.

The whole of the vast Quebec territory lying north of a line joining Pointe des Monts and Rupert House on James bay has a cool summer and a long and severe winter, and reports from the few observers in the district indicate that the climate is not suitable for any extensive agriculture, although garden stuff will mature in the more southerly localities.

Maritime Provinces.—The maritime provinces have a climate which is in many respects comparable with that of southern Ontario, but there are important differences. The spring opens somewhat later near the sea, and in a latitude somewhat higher, and the summers, while a little warmer than in the south of England, are rather cooler than in the peninsula of Ontario. Temperatures exceeding 85° and at times 95° are by no means infrequent during the summer months. After September the temperature declines quite rapidly, and while October is a month of much fine weather, night frosts are liable to be severe, and towards the close of November the normal daily temperature falls below the freezing point.

The winters in Nova Scotia are not quite as cold as in southern Ontario, but over the greater part of New Brunswick they are colder, and, taking Fredericton as a good example of prevailing winter conditions, we find them closely comparable with those of western Quebec where zero temperatures occur quite frequently between mid-December and the first of March. The precipitation which is ample throughout the provinces is heaviest along the south shore of Nova Scotia where it exceeds 50 inches, while between 40 and 50 is more general. The snowfall is very heavy in northern New Brunswick where it exceeds 100 inches. It diminishes southward towards Nova Scotia where the precipitation accompanying winter storms is usually partly in the form of rain.

Meteorological Table

	Jan.	Feb.	Mar.	Apr.	May	June	July	Augt.	Sept.	Oct.	Nov.	Dec.	Total
Normal Duration of Bright Sunshine (in hours)													
Victoria, B.C.	55	83	146	187	218	230	300	269	186	121	61	45	1901
Edmonton, Alta.	79	125	174	212	222	242	273	256	184	150	87	77	2081
Winnipeg, Man.	101	131	162	201	244	245	274	253	172	124	85	74	2066
Toronto, Ont.	79	108	154	187	223	262	283	252	207	148	84	66	2053
Quebec, Que.	81	103	150	168	199	204	223	209	157	118	69	71	1752
Fredericton, N.B.	110	124	154	185	205	218	237	223	178	151	91	94	1970
Normal Mean Daily Temperature (Fahrenheit)													Mean
Victoria, B.C.	39	40	43	48	53	57	60	60	56	50	44	42	49
Edmonton, Alta.	6	11	23	41	51	57	61	59	50	42	24	16	37
Winnipeg, Man.	4	zero	14	38	52	62	66	63	54	41	21	6	34
Toronto, Ont.	22	22	29	41	53	63	68	67	59	47	36	26	44
Montreal, Que.	13	15	26	41	55	64	69	67	59	47	33	19	42
Fredericton, N.B.	13	15	26	39	51	60	66	63	55	43	33	19	40
Normal Mean Daily Maximum Temperature (Fahrenheit)													Mean
Victoria, B.C.	44	45	49	55	61	65	69	69	63	56	49	45	56
Edmonton, Alta.	16	21	35	53	64	70	74	72	63	53	33	25	48
Winnipeg, Man.	6	11	26	49	64	74	78	75	65	51	30	16	45
Toronto, Ont.	29	29	36	50	62	72	78	76	68	55	43	33	53
Montreal, Que.	21	22	33	49	64	73	78	75	66	53	39	26	50
Fredericton, N.B.	24	27	37	49	63	72	77	74	66	54	41	28	51

WATER POWER IN CANADA

Sir Clifford Sifton

The limits assigned to this article preclude the introduction of any historical or descriptive matter. It is necessary, without any preliminaries, to plunge in *medias res*.

Picture to yourself the northern half of this continent, excluding Alaska, as divided into four great slopes. From ocean to ocean there are hills and hollows, lakes and rivers, deep valleys and great mountains. Nevertheless the country in its broad features is divided into four drainage areas. The first of these lies between the Great Lakes with their connecting rivers including the St. Lawrence and the height of land between them and Hudson's bay. The waters of this area find their way to the sea through the St. Lawrence river. Great power-producing rivers in this region are the Nipigon, the Kaministikwia, the Niagara, the Ottawa, the St. Maurice, the Saguenay, and the St. Lawrence itself. The second drainage area is comprised of the territory to the north and northwest. Rivers north of the height of land, many of good size, flow into James' bay and Hudson's bay. From the source of the Rainy river to the Rocky mountains the rivers find their way to Red river, to Lake Winnipeg, to the Nelson river and thence to Hudson's bay. Notable power-producing rivers in this area are the Bow, the Saskatchewan, and the Winnipeg, of which the latter is much the greatest in potentiality. The third area is comprised of the territory which is drained by the Mackenzie river through which the waters of that region find their way to the Arctic ocean. The fourth area is that which trends from the great divide of the Rocky mountains towards the North Pacific ocean. The greatest of the rivers draining this area is the Fraser.

Within the limits of Canada there are 125,000 square miles of water area, and it is this water area which is the source of the wealth of Canada in water power. Speaking in general terms these waters, thirty years ago, were used for domestic purposes, for sanitation, for drainage, and for navigation. Scattered widely through the country were individual water powers used largely for local manufacturing. Utilisation on the scale with which we are now familiar was unknown.

Thirty years has wrought a revolution. To-day the record stands as shown in the following table, in which is given for each province

(1) the water power developed with turbine installation; (2) the water power capable of being developed at minimum low-water flow, dependable for 12 months in the year; and (3) the high water capacity, dependable for six months in the year:

CAPACITY AND DEVELOPMENT OF CANADIAN WATER POWER

Province or territory	With turbine installation, h.p.	Cap'ty at minimum flow, 12 mos., h.p.	Cap'ty dependable for 6 mos., h.p.
British Columbia....	355,517	1,931,142	5,103,460
Alberta.............	33,067	475,281	1,137,505
Saskatchewan.......	No development	513,481	1,687,756
Manitoba...........	162,025	3,270,491	5,769,444
Ontario.............	1,445,480	4,950,300	6,808,190
Quebec.............	1,117,533	6,915,244	11,640,052
New Brunswick.....	44,539	50,406	120,807
Nova Scotia........	54,650	20,751	128,264
Prince Edward I.....	2,239	3,000	5,270
Yukon and N.W.T...	13,199	125,220	275,250
Total (Jan. 1st, 1924)	3,228,249	18,266,316	32,075,998

Regarding these figures it may be remarked that the 3,228,249 h.p. for which turbine installation has taken place, is all in actual use at peak loads, except a small proportion. This small proportion is mostly in connexion with the larger powers, for which machinery has not yet been installed to make use of the full development. In all such cases the machines are being regularly and rapidly installed.

With regard to the totals of available horse power not developed, the above figures err, if at all, on the side of safety. Dominion and provincial governments, various allied organisations, and private corporations have done a very large amount of laborious, scientific work during the last twenty years for the purpose of ascertaining the true figures. Every possible allowance has been made to prevent exaggeration. Where actual surveys have not taken place, the principles upon which calculations are based have been scientifically tested and the figures given can be relied upon as being well within the actual reality.

In some specific cases these figures can be compared with actual developments which have taken place since they were compiled and others that are now taking place. In every such case the actual amount of power capable of being developed proves to exceed, in some cases very largely, that which is specified in the schedule upon which the above statement is based.

It is certain also that as work actually proceeds, the amount of horse power available for twelve months in the year will be found to be considerably in excess of the minimum above set forth, because, as the work goes on, conservation of the water is effected, storage basins

are utilised, flow is regulated, and the flood waters are imprisoned; thus the dependable minimum flow of the streams is largely increased.

It may safely be said that the amount of power available for twelve months in the year will lie somewhere between the minimum of 18,000,000 and the maximum of 32,000,000. Probably 25,000,000 would represent the capacity actually capable of being developed and dependable for the whole year.

Of the actual development 3,228,249 h.p., it is impossible accurately to detail the uses, but some general figures may be given, which will serve partially to illuminate the subject. It will be readily understood that the rapid progress of hydro-electric enterprise makes it impossible to secure figures that are entirely up to date.

The power used in Canada by central stations, which sell to the public and to municipalities for light, cooking, domestic use, manufacturing, street railway purposes, etc., represents now considerably over 2,000,000 h.p., excluding what is sold to pulp and paper mills for their use in manufacturing. The pulp and paper industry accounts directly for about 700,000 h.p. The residue of the 3,228,249 h.p. is applicable to miscellaneous uses. Mining industries and private corporations' installation for industrial purposes mainly absorb this residue.

With respect to the figures given above, two remarks may be made:

1st. The estimate of total available power is made on the basis of twenty-four hour power, and eighty per cent. efficiency of machinery.

2nd. The turbine installation will be found to be somewhat larger in a good many cases than is necessary to take care of the actual amount of water continuously available. Some deductions should be made for this factor which it is not possible to estimate with accuracy, but, taking all the powers into account, the factor is not sufficient to affect seriously the consideration of the subject.

The process of further utilising the water powers of Canada is proceeding with great rapidity. The present is a period of intense activity and progress. During the year 1923, 225,000 h.p. was added to the total turbine installation in the country, and works now actually under way, all of which it is safe to conclude will be completed within about three years, will add 900,000 additional h.p. to the total. In other words, when the works actually under construction are completed within three years from the present date, the total turbine installation will, in round figures, be 4,100,000 h.p. Further projects now definitely decided upon with respect to which work has not actually commenced, but which will be undertaken in the immediate future, will add something more than another million to the developed horse power.

The present installation of 3,228,249 h.p. represents in actual capital an expenditure of $620,000,000. As a slight indication of what this means to the people of Canada, it may be remarked that it is well within the mark to say that this 3,228,249 h.p. in actual use does not on the average cost the actual consumers more than $30 per h.p. per annum. It is impossible to get the actual cost, but it is known to be very much less on the average than $30 per h.p. Power cannot be developed in any other way than by water for less than $60 per h.p. per annum at the present cost of fuel and labour. The minimum saving, therefore, to the people of Canada in the use of hydro-electric power is over $30 per h.p. for 3,000,000 h.p. that is used, or a total of $90,000,000 per annum.

These figures, however, only faintly indicate the advantages which Canada derives from the use of hydro-electric power. Nature has denied to northern Ontario and Quebec the coal which is so prodigally bestowed upon some other countries. In these extensive northern territories are great mining properties which require large quantities of power for their successful working. Distributed through the mineralised area are to be found abundant water powers which are utilised for the working of the mines. Many of the mines which are in profitable operation, could not be operated at a profit if it were necessary to use power developed by the expensive process of steam boilers. Economical hydro-electric power permits the profitable operation of these mines. What would otherwise be useless and incapable of profitable exploitation becomes a great and valuable asset. The value therefore of the individual horse power in the mining territory is not to be measured in the dollar value according to the usual standard, because the horse-power unit, which may be rated as being worth $30, $40, $50, or $60 *per se*, by enabling mining properties, otherwise unprofitable, to be exploited, and huge profits to be derived therefrom, multiplies itself one hundred fold in value to the country.

A glance at the map will show that nature has distributed the great water resources of Canada in such a way as to be of the highest possible value. From British Columbia to the Bay of Fundy we find that the greatest of our water powers are so located as to be contiguous to our centres of population and to advantageous industrial sites. We thus possess the power so located as to be most economically utilised.

The advantage of this fact to Canada, just entering upon her career as an industrial nation, cannot be fully estimated. The increasing efficiency of the country in manufacturing, shown in the remarkable growth during recent years of manufactured exports, is largely the result of the use of hydro-electric power. This development, great as it is, is comparatively in its infancy. The persistent demand

for greater and greater quantities of electric power is one of the wonders of the present manufacturing situation. No person in Canada had the slightest notion five years ago that the huge quantities of power being developed would be absorbed as they have been. Nothing seems to be more certain than that every available horse power reasonably contiguous to the settled portions of the country will be, from this time forth, developed as rapidly as the projects can be undertaken, studied out, and carried to a conclusion.

The entire northern littoral, from Welland to the city of Quebec, is one continuous manufacturing site, possessed of great natural advantages. With the present high cost of labour and the small prospect of a reduction in labour costs, manufacturing locations that can furnish cheap hydro-electric power, combined with advantageous shipping facilities to the markets of the world, will exhibit a continuous and ever-increasing advantage over all other competing sites.

Canada, therefore, enters upon the second quarter of the twentieth century with a very substantial advantage over nearly all her competitors in manufacturing.

Treatment of the subject of water powers in Canada will be incomplete without special mention of some of the extensive distribution systems which have been built up during the last twenty years.

Easily first in these great enterprises is the Hydro-Electric System of Ontario, which, beginning from nothing about twenty years ago, delivers daily to its customers in the province of Ontario no less than 725,000 h.p. The Hydro Commission now produces from the Niagara river alone 675,000 h.p., and when the machines which it has in contemplation are installed at Queenston, its total development of power from Niagara will be 950,000 h.p. The plans of the chairman of this commission look to the doubling of this great production of power from other sources in the next few years.

The Dominion Power and Transmission Company operating in the Niagara peninsula distributes 65,000 h.p. to its customers.

Second only to the Ontario hydro-electric installation, are the great distributing systems which have their centre in the city of Montreal or vicinity, the most important of which are:

The Montreal Light, Heat & Power Company, with something like 200,000 h.p. actually in process of distribution, and large additions contemplated in the near future;

The great Shawinigan system at Shawinigan Falls, on the St. Maurice river, which distributes upwards of 200,000 h.p.;

The Canadian Light & Power Company with 30,000 h.p.;

The Southern Canada Power Company with 30,000 h.p.

On the Pacific coast the British Columbia Electric Company uses about 30,000 h.p. and the West Kootenay Power & Light Company has about 40,000 h.p.

In the central provinces the Winnipeg Electric Company is understood to have something like 90,000 h.p. developed and the Winnipeg Municipal Hydro-Electric plant something in excess of 35,000 h.p.

These are a few of the great distributing systems that have been built up, spreading their beneficent effects among the populations whom they serve, by distributing to them the power which furnishes light, which performs domestic functions at a great saving of manual labour, which renders easy and economical the large number of operations in the modern industrial community that require the use of power.

One of the later developments of the use of hydro-electric power, which is of great promise to the country at large, is the carrying of the benefits to the rural community. The hard labour required for carrying on much of the work incident to diversified agriculture can be largely abolished by systematic use of appliances operated by hydro-electric power. Cooking, washing, ironing, milking, feed-cutting and crushing are made easy. The Hydro-Electric Commission of Ontario is making its service to farms a special object of study. Much has already been done and this field presents a very promising prospect of extending help to the people in a quarter where it is urgently required.

The problem of Canada with respect to hydro-electric power is not one of development, nor is it one of utilisation. While it is generally unsafe to prophesy as to the future, it may be safely stated that the great problems of hydro-electric development have been solved. While some slight improvements, resulting in increase of efficiency, will no doubt be made from time to time by the perfecting of machinery and increasing engineering knowledge of natural processes, yet it remains a fact that in all human probability the broad lines of hydro-electric development have been solved and are settled for all time. The knowledge which a hydro-electric engineer requires now will be much the same as that which a hydro-electric engineer will require twenty or thirty years from now. No considerable change in that respect is considered possible.

So, too, with regard to utilisation, the main features of this problem have already been settled. Changes that may be made will be trifling in extent and more matters of detail than of principle. The use of electric power in the chemical industries, in the pulp and paper industry, in the mechanical industries, is pretty thoroughly understood, and the individual ingenuity of the users and their scientific advisers may be left to make such improvements as time and experience will suggest.

The problem of Canada, therefore, is not development, which is going on with intense rapidity, nor utilisation, which is proceeding very satisfactorily. The problem is one of preserving and regulating the waters which feed the thousands of turbines that have been installed. The 125,000 square miles of water area sends its great quantities of water by a multitude of outlets to the seas. The preservation and control of the flow of these waters is the great problem of Canada with respect to her water powers. Preservation of the forests in the drainage areas, systematic construction of works of conservation and storage basins, the prevention of rapid and improvident drainage, are the matters which demand national attention and which it may be said are now very thoroughly understood.

The utilisation of water powers on a large scale is one of the most useful enterprises that can be undertaken. It saves great quantities of coal which are thus permitted to be retained for future use in other and necessary directions. It more than cuts in half the cost of all power used in manufacturing. It renders possible a whole series of small but useful manufactures without the slavish labour which they formerly required. By furnishing power cheaply it converts what would otherwise be waste products of nature into assets of great value. Finally by inducing care of forests, conservation of water, utilisation of storage facilities, and regulation of water flow it prevents erosion of fertile lands, retains the necessary moisture in the soil, and preserves that balance which nature demands in order to produce her most beneficent results.[1]

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[1]For bibliography see appendix.

WATER POWER IN ONTARIO

Sir Adam Beck, Kt., LL.D.

Chairman of the Hydro-Electric Power Commission of Ontario

Nowhere else in the world is so extensive a populated area served with electrical light and power at rates so low as those which prevail throughout municipalities in the Province of Ontario, and this is due, primarily, to two facts: first, that adjacent to the populated areas of the province are situated the largest water powers in the world; and second, to the existence of a successful, municipally-owned undertaking by means of which a widespread distribution of electrical energy is made to the citizens of the province.

Ontario well Endowed with Water Powers.—The Province of Ontario is endowed with water powers, widely distributed over an extensive area. The boundaries of the province include an area of over 400,000 square miles, and its surface waters drain both to the Atlantic and to the Arctic oceans. The water-power possibilities of the streams draining through the Great Lakes system to the Atlantic have been well ascertained but much yet remains to be learned regarding the power possibilities of the streams draining through Hudson bay into the Arctic.

The total water power of the province has been estimated as about 6,000,000 horsepower but this estimate is of relatively little significance for purposes of comparison with other provinces or with other countries unless first of all a uniform basis for comparison has been established. There remains, also, much research yet to be prosecuted in connexion with the undeveloped water storage of the Province of Ontario. Any person looking over the more detailed maps of the northerly portions of the province cannot fail to be impressed with the great number, and, in the aggregate, the extensive area of the lakes distributed over these regions. Respecting, therefore, the question of grand totals of water powers in Ontario, it may be stated that preliminary estimates, which include Ontario's share in the water powers of her international waters, have indicated a total of some 6,000,000 horsepower. The total installed capacity of the plants already developed aggregates about 1,500,000 horsepower.

The Chief Water Powers of Ontario.—The largest water powers of the province are those on the Niagara and the St. Lawrence rivers,

the potentialities of which outweigh those of any other rivers. Ontario is the owner of Canada's equity in the water power of the Niagara river and of the international portion of the St. Lawrence river. Even if the actual power that can be developed under the present limitations of treaty stipulations or of engineering considerations be computed, it will be found that the power potentialities of these streams constitute a large proportion of the available power in the province.

Next in importance to the Niagara and the St. Lawrence rivers is the Ottawa river and its tributaries. The power on the main stream, which constitutes part of an inter-provincial boundary, is shared by the provinces of Ontario and of Quebec. Under conditions of controlled flow, Ontario's share of the power available on the main stream, together with that on the tributaries in Ontario, aggregates about 700,000 horsepower. Other important water powers are found in the Trent River watershed, tributary to Lake Ontario. There are nearly thirty sites, of which over one-half have been developed.

Tributary to Lake Huron are water-power streams with an aggregate potentiality at known sites of nearly 300,000 horsepower, of which about 100,000 horsepower is developed. Tributary to Lake Superior are power streams with an aggregate potentiality of about 300,000 continuous horsepower. About half of this total is on the Nipigon river, on which an initial development has been made for the municipalities of Port Arthur and Fort William by the Hydro-Electric Power Commission of Ontario. The outflow from Lake Superior through what is known as the St. Mary river constitutes an important water power which has been partially developed. In the extreme west of the province, the English and Winnipeg rivers, which flow into the Province of Manitoba, have important water powers; in Ontario these powers aggregate over 250,000 horsepower. There remains to be mentioned the water powers of the streams flowing from Ontario into James and Hudson bays. These streams have not yet been adequately appraised; the total water-power possibilities of known sites aggregate upwards of 1,000,000 horsepower.

Ontario as a Field for Water Power Development.—The Province of Ontario possesses many natural advantages, and as a field for the utilisation of hydro-electrical energy compares most favourably with any other large territories.

Climatically, the province is favourably situated. The single fact that precipitation throughout Ontario, both in amount and in its seasonal distribution, is sufficient for agricultural purposes is an asset of prime importance. The whole province is well watered with many streams and lakes replenished from the good annual precipitation; in consequence, the water-power developments are in most

instances exceptionally well protected. Its agricultural advantages for mixed farming are too well and widely known to require description here. The railway and inland water facilities of the province considered as a whole are excellent. In all the large municipalities of Ontario manufacturers may count upon obtaining adequate transportation facilities and unsurpassed educational, social, and general living conditions. The employer of labour contemplating the establishment of new industries finds, in the Province of Ontario, standards of living and of administration of public affairs equal and in many cases superior to those found elsewhere.

From this brief consideration of the natural advantages of the province it will be appreciated that from its agricultural areas including those devoted to fruit growing, from its forest lands, mines, and fisheries, there are made available supplies of raw materials for extensive industries with marked possibilities for an increasing exportation of farm and manufactured products. Such circumstances constitute a solid foundation of great promise upon which to establish a market for the consumption of hydro-electrical energy for domestic, commercial, and manufacturing requirements. In this connexion it is a noteworthy fact that in the commercial centres of the province where the greater proportion of the population resides, are situated the largest and most important water powers. Moreover, it must be remembered that Ontario has no natural supply of coal and, therefore, must import this necessity—both bituminous and anthracite. The supply in the past has come chiefly from the State of Pennsylvania. The rising cost of this fuel and the fact that manufacturers were dependent upon outside sources for their supply, have been phases of the power situation in the Province of Ontario which have greatly stimulated, and which doubtless will continue to stimulate, the utilisation of the water powers of the province along the lines of hydro-electric development.

Early Developments of Water Power in Ontario.—In the early part of last century there were in Ontario—as indeed in many other portions of the early settled districts of both Canada and the United States—numerous water-power developments, used for grist mills, carding mills, saw- and planing-mills and for general manufacturing purposes. Some of these early developments are still in successful operation, and in the aggregate the water power developed assumed substantial proportions. These plants have quite a significance so far as hydro-electric development is concerned, because many of them were made at very advantageous sites and for this reason constituted desirable installations to transform into hydro-electric plants. Many of them, as for example on the Ottawa river, have been transformed into hydro-electric plants of more or less modern type.

Early Developments at Niagara Falls.—The possibility of developing power at Niagara Falls early attracted attention, but it was not until substantial advances had been made in the art of transmitting power by electricity that the possibility of utilising more than a fraction of the power available became evident. A discussion of the water-power development in Ontario would be incomplete without a brief reference to the three large hydro-electric developments on the Canadian side of the river at Niagara Falls which have had so important a bearing upon the general hydro-electric economy of the Province of Ontario.

It was in 1889 that negotiations by a group of United States capitalists were carried on with the Queen Victoria Niagara Falls Parks Commission with a view to the development of power from Niagara waters within the area controlled by the Park Commissioners. These negotiations resulted in the completion in 1904 of a plant by the Canadian Niagara Power Company with a nominal installed capacity of 121,000 horsepower. By 1905 another large company—the Ontario Power Company—was delivering Niagara power from a plant which had been constructed with an installed capacity of 180,000 horsepower. In 1903, the Electrical Development Company commenced a plant for the development of 125,000 horsepower from the Niagara river. Later this company—re-named Toronto Power Company—was acquired by purchase by the Hydro-Electric Power Commission of Ontario which also acquired by purchase the assets, including the power plant, of the Ontario Power Company just referred to.

The splendid service given by these Niagara installations under the exacting conditions of overload—especially during the period of the Great War—reflects great credit upon the engineers and manufacturers responsible for the design and structural work entering into these installations. It must be recognised that the hydro-electric development of the present day has been an evolutionary process which is greatly indebted for its present attainment to the faithful efforts of those who brought the art of hydro-electric development up to the stage it had attained when the older developments at Niagara Falls expressed the last word of the art in their day. Financial and other considerations induced these pioneer Niagara companies to utilise only the head available at the falls. The new Queenston-Chippawa plant of the Hydro-Electric Power Commission obtains the full efficiency of the waters of the Niagara river by employing the total head utilisable from Lake Erie to Lake Ontario.

Water Powers Developed for Special Industries.—It should be recognised that along with the development of hydro-electrical energy for transmission and distribution for municipal, domestic, and general industrial purposes, there has also taken place in various parts of the

province a great development of water power for individual industrial purposes. The favourable legislation of the Province of Ontario, as well as many other factors, facilitates the satisfactory utilisation of provincial water powers for the development of industries.

For many years water power has been extensively used for the development of the pulp and paper industries. More recently, large hydro-electric developments have contributed to the success of mining operations in the Sudbury, Cobalt, Porcupine, and other sections of northern Ontario. Nickel, silver, gold, iron, and other metals, as well as many non-metallic minerals are known to exist over extensive areas in Ontario, and water power in the future will no doubt be requisitioned to an increasing extent in connexion with mining operations. Much of the water power developed at Niagara has been utilised in the electro-chemical industries. The great part played by Niagara power in the war is well known. The industries of the province absorb about 900,000 horsepower, of which about 100,000 horsepower is employed by special large industries, and probably over 300,000 horsepower by all the smaller industries; in addition, the electro-chemical industries take about 85,000 horsepower, the mining industries about 125,000 horsepower, and the pulp and paper industries about 250,000 horsepower.

Turning now from the more general consideration of the water powers of the province, it is necessary to refer at some length to the work of the Hydro-Electric Power Commission.

Hydro-Electric Power Commission of Ontario

In the realms of peaceful pursuits there is, perhaps, no more striking example of the beneficial results of co-operation in the general public interest than is found in the success which has attended the efforts of municipalities in the Province of Ontario to supply their citizens with cheap electrical light and power.

Practically all the cities, towns, and villages, as well as numerous townships and smaller organised communities of the Province of Ontario, are supplied with electrical energy at cost by means of a co-operative undertaking on the part of the municipalities themselves, administered by a commission especially empowered for this service by the legislature of the province.

The commission thus constituted is known as the Hydro-Electric Power Commission of Ontario. It acts as trustee for the co-operating municipalities.

An enterprise which, in less than fifteen years, has reached a stage of development which will soon involve the utilisation of 1,000,000

horsepower, some of it distributed as far as 250 miles from the point of generation; which serves over 380 municipalities, including practically all of the large cities, towns, and villages of the province; and which represents an investment of $250,000,000, is a remarkable achievement in public ownership. It will be interesting here to review very briefly the circumstances which prompted the initiation of the enterprise as well as the steps by which the whole undertaking has advanced to its present proportions.

Initiation of the Municipally-owned Enterprise.—Although far-sighted citizens of Ontario, from time to time, had commented upon the need of furnishing the province with a source of power for lighting and power purposes, other than from coal as a prime agency, it was not until about the year 1900 that such views began to take definite form for public consideration. In the year 1900 a special committee of the Toronto Board of Trade made a report directing attention to the possibilities of securing an abundant supply of hydro-electrical energy from the Niagara river. There were, at this time, in many of the municipalities of Ontario, citizens who had recognised the desirability of securing adequate supplies of electrical energy for both power and light at cost. The interest manifested in the power problem increased and was greatly stimulated by means of public meetings, and by discussions in the press.

Later, the municipalities made appeals to the provincial government for legislation to enable them to take action, and finally, as a result of the general movement on behalf of cheaper hydro-electrical energy, the government of Ontario, in 1903, provided the means by which a commission could be appointed by interested municipalities to investigate the supply and distribution of hydro-electrical energy. The authority thus granted resulted in the appointment by the municipalities of Toronto, London, Brantford, Stratford, Woodstock, Ingersoll, and Guelph of the Ontario Power Commission, composed of the following: E. W. B. Snider, Esq. (Chairman), Waterloo, Ontario; P. W. Ellis, Esq. (Vice-Chairman and Treasurer), Toronto, Ontario; W. F. Cockshutt, Esq., M.P., Brantford, Ontario; the Hon. Adam Beck, M.P.P., London, Ontario; Professor R. A. Fessenden, Washington, D.C., which, after a thorough investigation, published, in 1906, a comprehensive report. When the results of this investigation became known to those interested, and even before this early report was available for public distribution, the Provincial Government, in 1906, provided by special Act for the creation of the Hydro-Electric Power Commission of Ontario, the organisation now in existence, and at that time composed of the following: Adam Beck, Chairman; Geo. Pattinson; John Milne.

The original Act of 1903, which was repealed, provided for the generation, transmission, and distribution of electrical energy entirely by the municipalities, financed by them on their own account. The new legislation provided for the financing by loan from the government, the contracting parties undertaking to repay same in a period of thirty years.

In 1906, by-laws were passed by thirteen Ontario municipalities authorising their officials to make contracts with the Hydro-Electric Power Commission for a supply of electrical energy. From time to time, other municipalities entered the organisation until to-day over 380 municipalities have entered into partnership in the general undertaking.

The basic principle of the whole "Hydro" project is a partnership of municipalities formed to obtain electrical energy at cost, each municipality paying its proportion of the cost for the service received. The Commission, acting as trustee and agent for the municipalities, exercises both administrative and constructive functions, and has evolved a well-defined and successful working policy for the development, transmission, and distribution of hydro-electrical power under municipal ownership.

Those acquainted with the work of the Commission are aware that the fundamental basis on which power is supplied is that it must be sold "at cost", but not everyone is aware just what is meant by this term. "Cost", so far as the "Hydro" power is concerned, includes all charges arising out of the generation, transmission, and delivery of power to the municipalities. These charges include, for each municipality, its proper share of the interest and sinking fund for the cost of lands, stations, and equipment required for supplying power as well as a proportionate part of administration, operation, maintenance, renewal, insurance, and all other costs entering into the business of supplying electricity.

Financial Structure.—Certain principles, which the inaugurators of the "Hydro" undertaking believed sound, were laid as a basis upon which to administer the various assets in which the municipalities are concerned. These underlying principles briefly expressed are as follows:

First: The generation and transmission of power on a wholesale scale is dealt with by a commission which, although appointed by the government of the province, acts independently in the capacity of trustee for the partnership of municipalities.

Second: The local distribution of electrical energy within the borders of a municipality is, in general, under the administration of a public utilities commission appointed under the provision of the Public Utilities Act.

Third: Capital required for the plant for the generation and transmission of power is loaned by the government upon receipt of formal requisition from the commission. Contracts are entered into between the commission and the municipalities under the terms of which the municipalities undertake to repay in thirty years the moneys thus loaned by the government.

Fourth: The local distribution system is financed by the issue of municipal debentures. Provision is made in the rates charged to the ultimate consumers, for revenue with which to retire these bonds also, in twenty to thirty years.

Fifth: The commission supplies power to the municipalities, charging each municipality the actual cost. To do this, an interim charge is made monthly, based upon the estimated cost and, at the end of each year, credit or debit adjustment is made of the amount charged in order to make up the actual total cost. The "cost of power" includes all the usual costs of operation and maintenance of the generating, transforming, and transmission plant and equipment, and, in addition, the annual interest charges on the moneys borrowed for the initial cost of installation, also provision for renewal (depreciation) and sinking fund reserves, as well as a special reserve fund for contingencies.

Sixth: Each municipality sells electrical energy to its own local consumers at rates and under conditions approved by the commission. The rates charged to its own consumers by a municipality are made sufficient to take care both of the cost of distribution within the municipality and of the estimated cost of power to be paid to the commission by the municipality. The cost of distribution is ascertained in a manner identical with that used by the commission in arriving at its wholesale costs.

Seventh: Under the Power Commission Act, the commission is required to determine, annually, the actual cost of service supplied to the municipal corporations by the local commission for such strictly municipal purposes as street lighting, street railways, and operating electric-motor-driven pumps in waterworks, and if any profit has accrued through the charging of the rate used throughout the year, this surplus is handed back to the municipality.

Growth of the Municipally-owned Enterprise.—The Hydro-Electric Power Commission initiated the distribution of electrical energy with power purchased from existing companies having extensive plants already erected at Niagara Falls. By the end of 1910 the first transmission lines and stations were ready for operation and power was distributed to a number of municipalities. The small initial load of less than 1,000 horsepower rapidly increased until the commission had

reached the limit of the contract which it had made with the Ontario Power Company for the delivery to the commission of power up to 100,000 horsepower. In 1920 the load was 356,000 horsepower, and to-day, including exported power, the commission is distributing about 750,000 horsepower. At the present time the commission operates twenty-two water powers which, when fully developed, will have an aggregate potentiality of over 1,000,000 horsepower.

In the construction of the transmission lines and its various systems, the commission has had in view the linking together of the various systems, until the whole of southern Ontario will practically be linked together into one vast transmission network. This will effect economies in the use of water and ensure greater dependability by interconnexion.

Transmission, Voltage, etc.—It is interesting to note that the frequency employed is 25 cycles in the Niagara system and 60 cycles in all other systems. In the Niagara system the main high-tension lines are operated at 110,000 volts and are carried on steel towers. The secondary distribution from the main transformer stations to the various municipal and distribution stations is chiefly at 13,000 and 26,000 volts, although other voltages are employed. Outside of the Niagara system the only 110,000-volt lines are in the Thunder Bay district where about 70 miles of wood-pole line is operated at this voltage. The main transmission lines of the Severn, Eugenia, Wasdells, and Muskoka systems are operated at 22,000 volts; the St. Lawrence system and the Rideau system lines at 26,400 volts; the Central Ontario and Trent system lines at 44,000 volts, recently raised from 26,400 volts—at which some lines still operate—and the Nipissing system lines at 22,000 volts. Local distribution in the various systems is usually at 2,200 and 4,000 volts, the service voltages being 110, 220, 550, and 2,200.

Power Developments by the Hydro-Electric Power Commission.—Although the first power distributed by the commission was purchased from existing companies, the municipalities soon found it necessary to develop water powers in order to meet their rapidly growing needs.

The first development completed was one of 1,200 horsepower at Wasdells falls on the Severn river. The second was the Eugenia development, the highest head plant in Ontario (gross head 552 feet). Other developments included those made on the Trent river to supply municipalities in central Ontario and on the Nipigon river to supply the special demands in the Thunder Bay district. The greatest power development made by the commission is the Queenston-Chippawa development undertaken to supply the rapidly growing demands of the Niagara system. Certain other developed water powers have been

purchased on behalf of the municipalities and have been extended or improved by the commission.

Thunder Bay System—Nipigon Development.—The principal effort made by municipalities to provide hydro-electrical energy for the opening up of new territory by the development of its natural resources is what is known as the Nipigon development of the Thunder Bay system. There is a large territory lying in Ontario at the head of the navigation of the Great Lakes which is rich in pulpwood and other resources, including extensive unexploited iron ore reserves.

The municipalities of Fort William and Port Arthur situated at the head of the Great Lakes arranged through the Hydro-Electric Power Commission for the development of the extensive water powers of the Nipigon river,—an admirable stream on which to develop power. Here there is a potentiality aggregating 200,000 horsepower. The commission has installed a plant at Cameron Falls with an ultimate capacity of 75,000 horsepower, utilising a head of 78 feet. The demand for power from this plant has been so great that the commission has planned to complete this installation at the earliest possible date.

Queenston-Chippawa Development.—The expanding market for electrical energy compelled the commission to undertake the construction of what is the largest individual hydro-electric plant in the world. This plant is known as the Queenston-Chippawa power development and utilises a head of 305 feet on the Niagara river.

Earlier power developments on the Niagara river only utilised that portion of the total fall of the river which occurs in the vicinity of the falls. The Queenston-Chippawa development uses 305 feet of the total fall of 327 feet available in the river. In the Queenston-Chippawa plant 30 horsepower is developed on an average for every cubic foot of water used per second.

The general scheme of development comprises an intake structure in the Niagara river at Chippawa; the deepening and widening of the Welland river between Chippawa and Montrose, a distance of four and one-half miles; the construction of a canal eight and one-half miles long from Montrose to the forebay and screenhouse at a point on the cliff about a mile south of the village of Queenston; and the construction and equipment of a power house in the gorge immediately below the forebay.

Among the special features of the canal may be mentioned the massive electrically-operated control gate located near Montrose, for controlling the flow in the canal; the deep excavation at Lundys Lane crossing; the various railroad and highway crossings over the canal; and the "Whirlpool Section". The last named is that part of the canal which crosses a gorge, on older channel of the river.

The building required to house the generating and transforming equipment for the completed development is of majestic proportions—the total length will be 650 feet, while the roof will be 160 feet above the river level, and the entire height from the bottom of the tail race to the highest portion of the building is only slightly less than 200

FIG. 10. QUEENSTON-CHIPPAWA POWER DEVELOPMENT—NIAGARA RIVER

Diagrammatic bird's-eye view showing intake from Niagara river above the falls, with Welland River section in fore-ground, leading water to control works at upper end of canal which stretches to power house near Queenston, Ontario, where water is returned to the Niagara river.

feet. The structure is composed entirely of fire-proof materials—concrete, brick, and steel.

The total length of the canal is twelve and three-quarter miles. At one point the bottom of the canal is 143 feet below the original ground level. The maximum depth of cutting in earth was 80 feet, and in rock, 85 feet. The width of the finished rock-cut portion of the canal is 48 feet and the depth of water is from 35 to 40 feet.

FIG. 11. QUEENSTON-CHIPPAWA POWER DEVELOPMENT—NIAGARA RIVER

Portion of the power canal looking south from Lundy's Lane curve, showing concrete lining completed. The width of the canal is 48 feet, and the floor of the canal at this point is 140 feet below the surface.

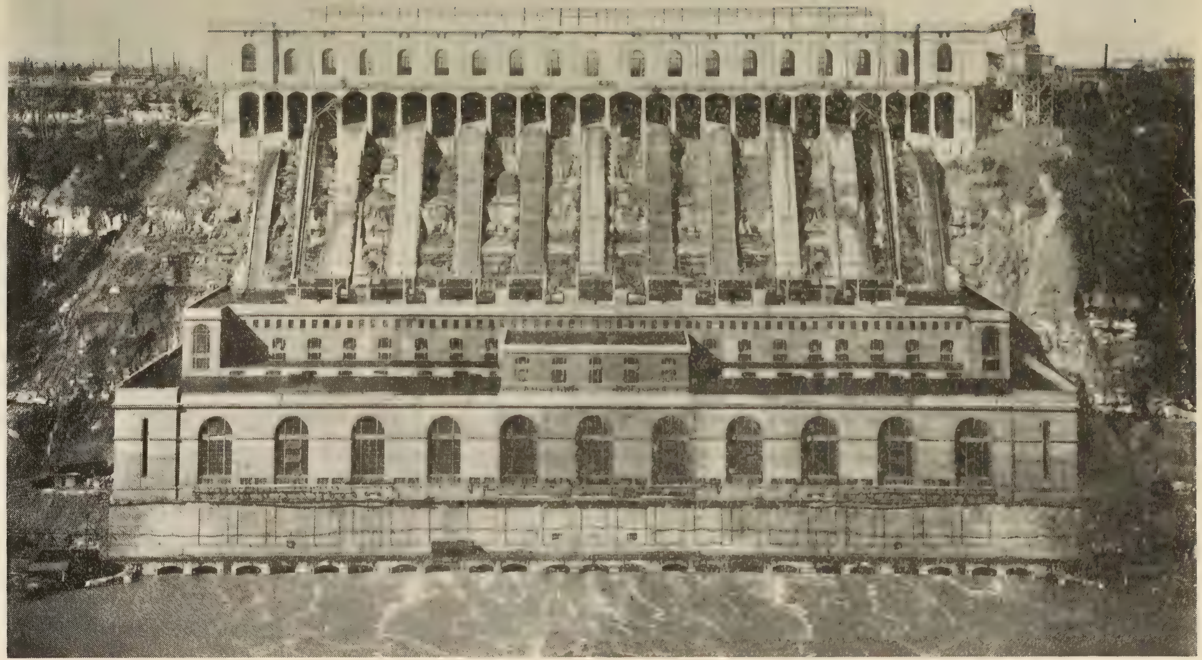

FIG. 12. QUEENSTON-CHIPPAWA POWER DEVELOPMENT—NIAGARA RIVER

The great power house on the Niagara river at Queenston, as it will appear when completed.

The amount of material excavated from the canal proper is over 17,000,000 cubic yards of earth and rock; the earth excavated amounts to 13,200,000 cubic yards, and the rock excavated to 4,182,000 cubic yards. Concrete to the amount of 450,000 cubic yards has been used in the construction of the canal; in June, 1921, 62,000 cubic yards of concrete were poured in 25 working days.

Preliminary work on the canal was commenced in May, 1917, active excavation with the large shovels in March, 1918, and the canal was completed in December, 1921. At one time 8,100 men were employed on the construction work.

Six of the large new generators are now under load supplying the Niagara system. The remaining generators will all be installed by 1926. The power canal provides for ten generators with an ultimate plant capacity of over 600,000 horsepower.

Foresight is Necessary.—Realising as it does the large amount of time—often several years—that must elapse between the initiation of a new, extensive water-power development and its being brought to the stage where commercial power can be delivered, the Hydro-Electric Power Commission has always been compelled to take early action on behalf of municipalities for the creation of new sources of supply for electrical energy.

At the present time, all evidences point to the fact that by the end of the year 1926, the present provisions made for the supply of electrical energy to Hydro municipalities will be fully taxed and no spare power will be available. The output of the Queenston-Chippawa plant will have been absorbed. The commission has considered the possibility of producing further power at Niagara Falls, but it is believed that it will be more profitable for all the municipalities concerned to turn to the St. Lawrence river for the next large hydro-electric development.

Power on the St. Lawrence River.—The Province of Ontario has a half interest in the water power in the international stretch of the St. Lawrence river which extends from Lake Ontario to the international boundary. In this portion of the river, there is a possibility of developing about 1,600,000 horsepower, of which 800,000 horsepower would belong to Ontario.

For several years the commission has been conducting special surveys and investigation along the St. Lawrence river in order to determine the best means of developing the international reach of the river in the joint interests of power and of navigation.

In the international portion of the St. Lawrence river there are two important power sites, one in the vicinity of Morrisburg, Ontario, and the other at the Long Sault rapids near Cornwall, Ontario. It is

anticipated that the upper power site at Morrisburg will, at an early date, be developed in the interests of the citizens of the Dominion of Canada and of the United States.

What Ontario Municipalities have accomplished.—Some idea of the great success attained and of the various operations involved in the working out of the principles basic to this municipal undertaking, may be obtained from the Annual Reports of the Commission. These annual reports give more information respecting the operations of the commission and the associated municipal electric utilities than any annual report of any other system of electric utilities, regardless of where operated or whether publicly or privately owned.

Throughout Ontario municipalities, the use of electrical appliances is greatly promoted by the low cost of electricity. In most of these municipalities, the average family may take full advantage of the cleanliness, convenience, and safety of electric lighting for less than $1.00 per month; while for a small additional cost, electric fans, irons, washing machines, vacuum cleaners, toasters, and certain classes of light cooking appliances may be utilised. Cooking by electricity is rapidly becoming popular. Many industries have been attracted to the province as a result of the work of the Ontario municipalities.

As is customary in electrical supply, the rates in Hydro municipalities are so graded that the rates for all energy used over a certain consumption are lower than for the initial consumption. In many Hydro municipalities this secondary or "follow-up" rate is as low as nine-tenths of a cent per kilowatt-hour, and recently the commission felt justified in inaugurating a scheme whereby the maximum "follow-up" rate in all Hydro municipalities is 1.8 cents per kilowatt-hour, for domestic service. Nowhere in the world over such extensive areas do communities and citizens obtain electrical power and light at such low rates as prevail throughout the Hydro municipalities in the Province of Ontario.

There is here presented a table based upon the returns published in the last printed Report of the municipalities:

CHARGES FOR ELECTRICAL SERVICE IN ONTARIO MUNICIPALITIES

Municipality	Population	Approximate transmission distance in miles from generating plant	Average net charge to consumers inclusive of all charges		
			Residence service, cents per kilowatt-hour	Commercial service, cents per kilowatt-hour	Power service, dollars per horse-power per year
Toronto	522,942	90	2.1	2.7	22.58
Hamilton	118,243	50	1.9	1.3	14.49
Ottawa	112,899	1	1.4	1.9	11.75
London	59,784	132	1.8	1.7	22.66
Windsor	38,530	250	2.6	2.7	28.64
Brantford	31,362	85	1.9	2.6	16.33
Kitchener	22,717	102	1.7	1.9	18.78
Peterborough	21,439	2	2.8	1.5	16.46
St. Catharines	20,961	9	1.3	1.4	16.40
Guelph	18,027	77	2.3	2.4	17.16
Niagara Falls	15,895	1	1.5	1.2	14.32
Galt	13,332	93	1.8	2.0	17.55

Rural Distribution.—This reference to the operations of the Hydro-Electric Power Commission of Ontario would be incomplete without mentioning some of the results achieved by Ontario municipalities in bringing to small communities and to individual farmers the inestimable advantages of electrical service.

The difficulties of electrification of country districts are universally recognised. In spite, however, of the handicaps inherent in rural distribution of electrical energy, the Hydro-Electric Power Commission has made substantial progress in this department of its activities. Its first rural lines were built late in 1912, but in 1917, their construction was suspended due to war conditions. Recently, under revised legislation, great strides have been made and the commission has now constructed about 850 miles of rural lines giving electrical service to about 14,000 customers.

Although the aggregate load distributed to the rural dwellers is, and must always be, but a relatively small proportion of the energy distributed by the Hydro, its influence upon the economic life of the Province of Ontario is already a factor of great importance.

Character of Service Received in Rural Districts.—Hitherto the rural resident has thought chiefly of electrical service in connexion with lighting, but his greater need is for convenient power. The appliances that are so helpful to the city dweller, such as washing machines, irons, fans, etc., are of even greater help to the farmer's wife; but, in addition, the farmer can make use of a large number of devices which are even more labor-saving than those used in the city, such, for example, as water-pumps, cream-separators, churns, milking machines, and similar small-power machinery. These can all be operated by

quite small motors. Where larger capacity electrical service can economically be installed, additional machinery, for which the farmer usually employs auxiliary power, can be operated electrically; such, for example, as buzz- and drag-saws, choppers, root-pulpers, ensilage cutting boxes, and threshers.

As typical of the charges that obtain for rural electrical service, it may be stated that for the class known as "light farm service", which includes the lighting of farm buildings, power for miscellaneous small equipment, power for single-phase motors not to exceed 3-horse-power demand, or for an electric range, the range and motors not being used simultaneously, the monthly charge would be from $6.00 to $8.00.

Conclusion.—The policy of the government of the Province of Ontario has been, and is, to afford the greatest possible inducement to those requiring to develop water power in connexion with their industrial operations. What has been accomplished by private enterprises as well as by the co-operative efforts of the municipalities of Ontario, will well repay close examination by all interested in the development of hydro-electrical energy.

There is to-day available a great deal of information respecting the water powers and the natural resources of the province, which information was not available when many of the enterprises now in existence were initiated. Reports upon the resources of the Province of Ontaro, issued by government departments, are available for distribution to those interested. The Hydro-Electric Power Commission issues a comprehensive detailed report dealing with its varied activities.

It is doubtful if the opportunities afforded manufacturers for obtaining supplies of hydro-electrical energy for general domestic, commercial, and industrial purposes in the Province of Ontario can be surpassed. Electrical energy, once a luxury, has, in Ontario, been so reduced in cost that it has become a common commodity for the service of all. In a true adaptation of a well-known expression it may be said that " it is the power of the people made usable for the people by the people".

PIONEER TRANSPORTATION IN CANADA

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Pioneer transportation in Canada was very largely water transportation. Long before even primitive roads were available, and long before railroads were dreamed of, the sparse population made its way about by means of the rivers and lakes of the country.

The extraordinary richness of Canada, east and west, in these water thoroughfares, must be apparent to anyone who has studied a map of the Dominion. The St. Lawrence leads directly into the heart of the continent. From the western end of Lake Superior, water routes, involving various portages, enable the traveller to reach Rainy lake, and, by way of Rainy river, the Lake of the Woods, and Winnipeg river, he is brought to Lake Winnipeg.

From Lake Winnipeg he can travel by water, with nothing more than an occasional portage, west to the Pacific, north to the Arctic, north-east to Hudson bay, or south to the Gulf of Mexico. To reach the Pacific, he would ascend the Saskatchewan from Lake Winnipeg, and find passes through the Rocky mountains at the headwaters of both the north and the south branch; or he could by any one of several water routes reach the Athabaska from the Saskatchewan, and get through the mountains by Athabaska pass; or again he could reach the mountains by way of the Athabaska, Lake Athabaska, and the Peace river. West of the mountains, Peace river would lead him to the headwaters of the Fraser, and the other passes to the headwaters of the Columbia. Both the Fraser and the Columbia would take him down to the Pacific, though the former would give him a very tumultuous passage, as both Simon Fraser and Sir George Simpson found in their day.

To reach the Arctic, the most direct route would be by way of the Athabaska, Lake Athabaska, the Slave, and Great Slave lake, to the Mackenzie, which empties into the Arctic. From Great Slave lake he could reach the Arctic by way of Clinton-Colden lake and Backs river, or by Great Bear lake and the Coppermine.

The principal route of the fur traders from Lake Winnipeg to Hudson bay was by Hayes river, but it was also possible, though difficult, to reach the bay by Nelson river, or by using the Cumberland Lake route from the Saskatchewan to the Churchill.

To get to the Gulf of Mexico from Lake Winnipeg, it was only necessary to ascend the Red river and portage over to the upper waters of the Mississippi. The Mississippi could also be reached by various portage routes from the Great Lakes, from Lake Erie by way of the Ohio, from Lakes Michigan and Superior by means of small streams that led to tributaries of the Mississippi.

Also, in the east, the Atlantic coast could be reached by water routes from Lake Ontario to the Hudson, and from the St. Lawrence by the Richelieu river and Lake Champlain to the Hudson. And toward the north, many routes were available, and used more or less by fur traders; from the Great Lakes and the St. Lawrence to James bay, by the Albany or the Moose from Lake Superior; and from the St. Lawrence, by the Ottawa and the Abitibi, by the St. Maurice and the Nottaway, and by the Saguenay and the Rupert rivers.

As this marvellous water system was opened up, a number of portage routes came into use, some of which in time became famous. Probably the most notable of these was the Grand Portage route, which led from Lake Superior over the height of land to waters flowing west into Lake Winnipeg and eventually into Hudson bay. Grand Portage was for many years the connecting link between the east and the west, the doorway to the vast Indian country, the fur-trader's paradise.

Other portage routes from Lake Superior to the westward were by way of the Kaministikwia river, by the St. Louis river, and by Lake Nipigon. The Kaministikwia route lay up the river of that name, at whose mouth the city of Fort William now stands, and thence by a series of lakes and rivers to Rainy lake. The Fond-du-Lac route ran up the St. Louis river, from where Duluth stands to-day, and by way of Vermilion river and Lake Namakan to Rainy lake. The Nipigon route was more roundabout. From Lake Superior, the traveller ascended Nipigon river to the lake of the same name, then westward through a series of lakes and streams to English river, a tributary of Winnipeg river.

The Kaministikwia was the earliest of these portage routes to be discovered. In 1688, Jacques de Noyon followed this route to Rainy lake. La Jemeraye, nephew of the western explorer La Vérendrye, first used the Grand Portage route in 1731, and it continued in use until the beginning of the following century, when the Canadian fur traders, organised as the North-West Company, finding that the authorities of the United States had determined to levy customs duties on goods landed at Grand Portage, decided to adopt the Kaministikwia route, which had been rediscovered by Roderick McKenzie in 1798. It is not known when the St. Louis or Fond-du-Lac route was discovered,

but it was a recognised thoroughfare of the fur trade for half a century or more. The Nipigon route was discovered by Umfreville in 1784, but was never used to any extent.

Disregarding a number of minor portages, on the various routes between Lake Superior and the Lake-of-the-Woods, and on the Winnipeg river, the next notable portage is at Grand Rapids, where the Saskatchewan discharges its waters into Lake Winnipeg. Ascending the Saskatchewan, about midway between its mouth and the confluence of the North and South Saskatchewan, a portage route leads north by way of Cumberland lake. Trading posts were built on this lake in the early days of the fur trade, by both the Hudson's Bay Company and the North-West Company. Joseph Frobisher, one of the traders from Montreal, first discovered and named Frog portage, long known as Portage de Traité (or Traitté), which connected the Churchill with the Saskatchewan, in 1774. Peter Pond, following Frobisher's lead, turned up the Churchill to its source in Lac-la-Loche, and discovered Methye portage or Portage la Loche, in 1778. This portage, noted for its beautiful scenery, which has been described by Mackenzie, Franklin, Back, and other northern travellers, leads from the Churchill over to the Clearwater, and so to the Athabaska and the vast systems of northern and western waterways that lie beyond. Another important key to the water systems of the west was Giscome portage, leading from the headwaters of the Parsnip, a branch of the Peace river, to the upper waters of the Fraser.

The earliest of Canadian travellers, who were sometimes explorers, sometimes fur-traders, and often both, adopted the birchbark canoe of the Indian as the most efficient means of transport on North American waters. Because of the vital part this type of vessel played in the early history of Canada, and particularly of what is now western Canada, it seems worth while to quote the description in Keating's *Narrative of an Expedition to the Source of the St Peters River:*

"We were divided into three bark canoes, known by the name of 'canot du nord'. Although these are made nearly on the same model, yet there is great difference in their speed, burden, soundness, etc., according to the skill manifested in their construction. A canoe of this kind is generally constructed of ribs of cedar bent so as to impart to it its proper form, the ends being secured to a band that forms the superior edge of the vessel, and acts as a gunwale; over these ribs the birch bark is laid in as large pieces as possible, generally so that there shall be but two longitudinal seams, and two or three transverse; between the bark and the ribs very thin splints of cedar are placed, so as to prevent the bark from splitting; all the joints are sewed with long threads obtained by splitting the roots of a tree called by the

voyageurs *épinette*, and which is probably a spruce. To this thread the term *wattap*, used by the Chippewas, is applied by the Canadians; the seams as well as the cracks are covered with pitch (called by the Chippewas *peke*) made of the gum of the épinette; this is applied hot and renders the canoe water-tight. In this manner a little vessel is obtained, very well calculated for travelling on these waters, as it will carry a burden of upwards of 3,000 pounds. . . . Those which we used were 30 feet long by about 4 feet wide in the middle, and perhaps 30 inches deep. A number of transverse bars serve to keep the canoe in its proper shape. The seats of the paddlers are suspended to the gunwale. The bow and stern are sharp and turned upward."

How these canoes were navigated on all sorts of waterways, large and small, deep and shallow, is very well described by Peter Grant, of the North-West Company, in one of the narratives included in Masson's *Bourgeois de la Compagnie du Nord-ouest:*

"When arrived at a portage, the bowman instantly jumps in the water, to prevent the canoe from touching the bottom, while the others tie their slings to the packages in the canoe and swing them on their backs to carry over the portage. The bowman and steersman carry their canoe, a duty from which the middlemen are exempt. The whole is conducted with astonishing expedition, a necessary consequence of the enthusiasm which always accompanies their long and perilous voyages.

"It is pleasing to see them, when the weather is calm and serene, paddling in their canoes, singing in chorus their simple melodious strains and keeping exact time with their paddles, which effectually beguiles their labours. When they arrive at a rapid, the guide or foreman's business is to explore the waters previous to their running down with their canoes, and, according to the height of water, they either lighten the canoe by taking out part of the cargo and carry overland or run down the whole load.

"It would be astonishing to an European observer to witness the dexterity with which they manage their canoes in those dangerous rapids, carrying them down like lightning on the surface of the water. The bowman, supported by the steersman, dexterously avoids the stones and shoals which might touch the canoe and dash it to pieces, to the almost certain destruction of all on board. It often baffles their skill, when the water is very high, to avoid plunging in foaming swells on the very brink of the most tremendous precipices, yet those bold adventurers rather run this risk, for the sake of expedition, than lose a few hours by transporting the cargo overland.

"When they are obliged to stem the current in strong rapids, they haul up the canoe with a line, all hands pulling alongshore and some-

times wading through the water up to their middle, except one man, who remains in the stern of the canoe, in order to keep it in the proper channel; this part of their duty is always accompanied with much labour. When the wind favours, they always carry sail, and in a fresh gale will generally go eight or nine miles an hour."

Before leaving this primitive yet highly-developed vessel, it will be convenient to give a description of the method of carrying trading goods and fur packs over a portage, in the days of the North-West Company. Says John Johnston, in Masson's *Bourgeois:*

"Carrying the canoes, goods, and provisions (across the portage) is done by means of leather straps or thongs, the middle of which is broad and fitted to the forehead of the carrier. The first bale or piece is tied so as to lie a little above the *reins*, the second is lifted over the head and deposited, without tying, on the first, and, thus loaded, the *engages*, as they are called, trot off to the place chosen for a deposit, which they call a *pose*, and which in large portages are from two to three miles apart. This they repeat till the whole is transported; they then set off for the canoe, which they carry on their shoulders. They so go on till night, only stopping once for their meal, and once or twice for lighting their pipes. The packs are from 80 to 120 pounds weight, and he is not looked upon as 'a man' who can not carry two; there are many who even take three and outrun their fellows. This is the mode of carrying all over the Northwest."

The Hudson's Bay Company, with characteristic conservatism and preference for things that were substantial and strong, never took very kindly to the light and fragile canoe, although it was used to some extent after, and even before, the union of the Hudson's Bay and North-West Companies in 1821, but preferred, wherever it could be used, what was known as the York boats, so named after York Factory, on Hudson bay. Captain Butler describes one of these boats in 1870:

"The boat in which I now found myself was a large, roomy craft, capable of carrying about three tons of freight; it had a single tall mast carrying a large square lugsail, and also possessed of powerful sweeps, which were worked by the men in carrying positions, the rise of the oar after each stroke making the oarsman sink back upon the thwarts only to resume again his upright attitude for the next dip of the heavy sweep. This is the regular Hudson Bay boat, used for the carrying trade of the great fur company on every river from the Bay of Hudson to the polar ocean. It looks a big, heavy, lumbering affair, but it can sail well before a wind, and will do good work with the oars, too. . . My crew numbered seven hands."

So much for the smaller craft. On the larger inland waters of Canada sailing craft were introduced at a very early date. One of the first of these was La Salle's *Griffon*, built in 1679 on what is now the United States side of the Niagara river, near the mouth of Cayuga creek. The vessel was of forty-five tons burden, and was equipped with five small cannon. These, like the unwieldy anchor, had been brought across Lake Ontario from Fort Frontenac, and hauled painfully up the Niagara escarpment. The *Griffon* was launched in the spring, and in August, 1679, made her first and only voyage, through Lake Erie, the Detroit river, Lake St. Clair and the St. Clair river into Lake Huron, and, after remaining some time at Michilimackinac, sailed into Lake Michigan and over to the entrance to Green bay. From here La Salle sent the boat back laden with furs. She was lost on the way; no one ever discovered how or where.

A little over half a century later (1732) the French Governor of Canada, Beauharnois, wrote the Court that Louis Denys, Sieur de La Ronde, proposed to build two barques at his own expense, one on Lake Huron and the other on Lake Superior, to be used in transporting copper from Lake Superior to Niagara for trans-shipment to Quebec and France. The following year the French King approved the project. The barques were evidently built, or at any rate that on Lake Superior, as in La Ronde's memoir of 1738 he says, "I returned in my vessel to Sault Ste. Marie," and enters at length into the ambitious plans for developing copper mines. These plans came to nothing in the end, probably because of the excessive cost of transportation.

It is, of course, not practicable here to give a comprehensive account of the development of shipping on the inland and coastwise waters of Canada. All that can be attempted is to touch very briefly on a few outstanding facts that may serve to suggest the general course of that development. After Canada became a British possession, for instance, and the fur trade expanded from Montreal throughout the region of the Great Lakes and far into the prairie country beyond, sailing vessels were built and operated on all these waters for the purpose of carrying up supplies and bringing down furs. One of the most famous of these vessels was the *Nancy*, a schooner built at Detroit in 1789 for the XY Company, and taken over by the North-West Company in 1804. She was used as a transport during the war of 1812-14, and in the latter year was destroyed by her crew to prevent her from falling into the hands of the Americans.

At this time Canadian shipping on the Great Lakes had developed into quite respectable proportions, sufficient at any rate to supply the needs of the sparse population of Upper Canada. But its most notable

development was in ocean tonnage. While shipbuilding was a recognised industry on the St. Lawrence, it was one of paramount importance in the maritime provinces. Yarmouth, Nova Scotia, claims the credit of having started the industry as early as 1761, when a small schooner, the *James*, was built and launched. From that time onward the industry grew steadily in the ports of Nova Scotia and New Brunswick, the maritime fleet increasing from decade to decade not only in numbers but in individual tonnage. A century and a quarter after the launching of the *James*, Yarmouth, for instance, produced the *County of Yarmouth*, a full rigged ship of 2,154 tons. The industry reached its zenith about the time of the Crimean war, when Nova Scotia counted over three thousand vessels, with a tonnage of considerably more than half a million, scattered over the seven seas. With the advent of the iron sailing ship, followed by the tramp steamer, the Canadian shipbuilding industry was doomed. It left behind it, however, some notable achievements, for one of which at least it has never had much credit. One hears a good deal about the clipper ships of New England, their speed and their seaworthiness. As a matter of fact many of the finest of this type of vessel were built in Nova Scotia, and the most notable of the clippers that flew the Stars and Stripes were built in New England yards by "Bluenoses," such as Donald McKay, a Nova Scotian, who built the *Lightning*, *James Baines*, *Flying Cloud*, and many other famous clippers.

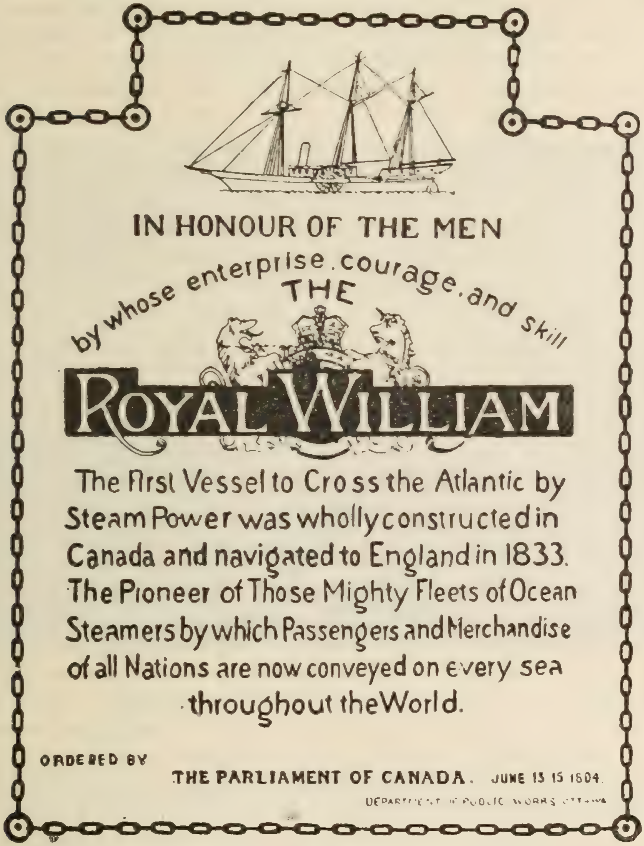
Pioneer transportation in Canada by water may be said to have ended with the introduction of steam. The first steamer in Canadian waters was the *Accommodation*, built by John Molson and David Bruce of Montreal, and which made its initial trip from Montreal to Quebec in November, 1809. Seven years later the steamer *Frontenac* was launched at Ernesttown, on Lake Ontario. It was not until 1843 that the first iron steamer was built in Canada, the *Prince Albert*, of Montreal.

In 1831 the *Royal William* was launched on the St. Lawrence, near Quebec, and towed up to Montreal to receive her engines. Two years later she made a transatlantic trip, reaching Gravesend in September—the first vessel to cross the Atlantic by steam-power alone. In 1834 the *Royal William* was sold to the Spanish government, and became Spain's first war steamer.

One of the shareholders of the *Royal William*, Samuel Cunard of Halifax, gave his name to the famous line of transatlantic steamships. Thomas Chandler Haliburton and Joseph Howe are credited with having conceived the idea in 1838. They took it up with Cunard and William Crane of New Brunswick, obtained a mail subsidy from the British government, and two years later the first Cunard mail steamer,

the *Britannia*, sailed from Liverpool for Halifax and Boston. She was followed by the *Acadia*, *Caledonia*, and *Columbia*.

In 1816 the first steamer appeared on the St. John river, New Brunswick, the *General Smyth*. In 1834 the *Beaver* was launched on



FACSIMILE OF THE MEMORIAL BRASS.

Fig. 13. THE TABLET ERECTED BY CANADA TO COMMEMORATE THE "ROYAL WILLIAM"

the Thames, in the presence of William IV. Built for the Hudson's Bay Company, she sailed around the Horn and reached Fort Vancouver in 1835. Another pioneer steamer was the *International*, a stern-

wheeler which afforded communication between Fort Garry on the Red river and the international boundary.

Before leaving this side of the subject, a word may be said about canals. The earliest lock canals in Canada, or in North America, were built by the Royal Engineers on the St. Lawrence, around the Coteau and Cascades rapids between 1779 and 1783. In 1798 a small canal was built by the North-West Company at Sault Ste. Marie. A canal on the Richelieu river, to connect the St. Lawrence with Lake Champlain and the Hudson river, had been advocated as early as 1775, but was not actually built until 1831. The first Welland canal was commenced in 1824, and the Rideau canal two years later.

So much for transportation by water. Pioneer transportation by land in Canada, up to the advent of the railway, was for the most part a painful experience, as the available roads were few and very primitive. Benjamin Franklin stated before a committee of the House of Commons in 1766 that the only post-road then in Canada was between Montreal and Quebec. This was a relic of the French régime, having been completed in 1734. The distance was divided into twenty-four stages. The *maîtres de poste* were obliged to keep four calèches and four carioles, "and to be ready at a quarter of an hour's notice to forward the traveller, who was usually received with much ceremony on alighting after each stage." The *maîtres de poste* had the exclusive right of passenger transport by land. The journey from Quebec to Montreal occupied three days, and the charge amounted to about fifteen dollars.

In 1791 the post-road extended eastward to New Brunswick and westward as far as Kingston. The first parliament of Upper Canada passed, in 1793, an Act placing the roads under overseers. The inhabitants were required to put from three to twelve days' labour on the highways, and to provide their own tools. Owners of carts and teams worked at least six days. The provincial revenue was so small that it was not until 1804 that any surplus was available for roads. Nevertheless some considerable progress was made. Governor Simcoe, in 1794, had, with the help of the Queen's Rangers, made a beginning with that since famous highway Yonge street, which starting at the lake front runs north through Toronto and for thirty-odd miles to Lake Simcoe. He also built Dundas street, from the village of Dundas on Lake Ontario (later extended to Toronto) to the site of what later became the town of London, which he thought of making the capital of the province. In time the intermediate links were completed, until main roads were available from Quebec to the Detroit river, and by way of Yonge street to Georgian bay.

In 1816 a stage was put on the route from Montreal to Kingston, and the following year another one was established from Kingston to York. During the season of navigation these stages were discontinued between Prescott and York, as the available traffic was taken care of by a steamboat. Various attempts were made in the early part of the nineteenth century to open a stage route from York to the Detroit frontier, but this was not finally established until the 'thirties. In 1827 the first stage was started between York and Niagara, and in

Fig. 14. RED RIVER CARTS
Half-breed hunters' camp near the "Three Buttes".

1842 a daily line was put in operation throughout the province. Similarly by slow degrees a system of roads was built up throughout the maritime provinces, and stages afforded communication between the principal towns.

In western Canada roads of any description are a comparatively recent development. So far as the prairie provinces are concerned, they were almost superfluous, as it was possible to ride or drive almost anywhere across the treeless plains; while in that sea of mountains, British Columbia, the building of any kind of road was such a difficult and expensive undertaking that it was not attempted until it became indispensable. Such an emergency arose in 1858 when gold was

found on the upper waters of the Fraser river and in the Cariboo district. Between that year and 1865 Governor Douglas completed what has been described as "the boldest undertaking in road-building ever launched by any community of twenty thousand people". It was eighteen feet wide and over four hundred and eighty miles long, and many miles of it were built by cribwork and blasting through the wild canyon of the Fraser, hundreds of feet above the river.

The first charter for a Canadian railway was granted in 1832, shortly after the news reached Canada of the success of the London and Manchester line. This pioneer Canadian railway, built in 1835-36,

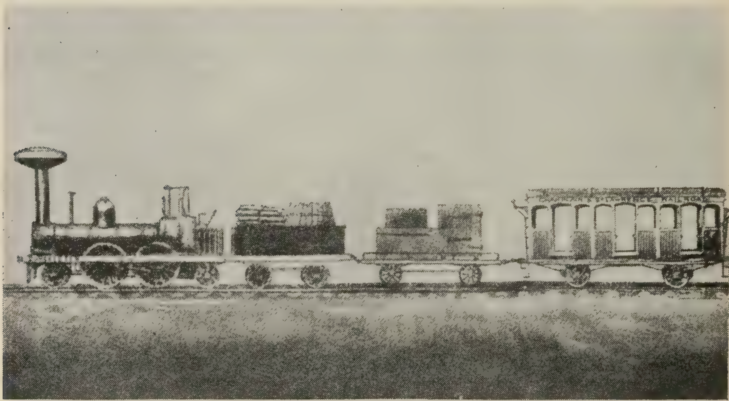


FIG. 15. THE FIRST RAILWAY ENGINE IN CANADA
Champlain and St. Lawrence Railway, 1837. From a print in the Château de Ramezay.

ran between Laprairie on the St. Lawrence and St. Johns on the Richelieu, from which point the river was navigable to Lake Champlain. The distance was sixteen miles. The road was opened with horses in 1836 and with locomotives the following year. The first railway in Upper Canada was built between Queenston and Chippawa, on the Niagara frontier, in 1839. The grades were so steep, however, that locomotives could not be used, and horses were substituted. In the late 'forties and the 'fifties a large number of railways were built in what was then Canada, and somewhat later in Nova Scotia and New Brunswick. Most of these were afterwards absorbed by the great Canadian systems, the Grand Trunk, the Canadian Pacific, and the Intercolonial.[1]

[1]For bibliography see appendix.

MODERN TRANSPORTATION IN CANADA

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Modern transportation in Canada by canal and rail dates back to the middle of the nineteenth century. By 1850 the main features of the Canadian canal system had been completed, additions to it having been chiefly in the form of extensions. At that time also the first important railway projects were beginning to take form. It is true that as far back as 1836 Canada had 16 miles of steam railway, but the slow progress during the next fourteen years is evident, for by 1850 only fifty miles of line had been added. The electric railway made its appearance in Canada about forty years ago, while the motor truck has become an appreciable factor in transportation only during the last decade.

Water transportation has always been of great importance to Canada. It was the first, and long the chief, means of communication between distant points. One province, Prince Edward Island, is entirely surrounded by water; Nova Scotia is a peninsula; and New Brunswick, for the most part, has water boundaries. In the early days the increased importance of the waterways was due to their extending far into the interior. The St. Lawrence river, with the Great Lakes, make a continuous waterway 2,400 miles long; while other lakes and rivers feeding this system form important subsidiary routes and mark the greater part of the length of the boundary between Canada and the United States. This great waterway is of special importance in that it affords an outlet to a large portion of the territory of two nations which are among the greatest producers in the world of raw materials. Canada occupies a commanding position in this respect because the last 1,100 miles of the St. Lawrence are in Canadian territory. In the readiness with which large expenditures were made on this great waterway, one sees an effort on the part of the Canada of a century ago to control a large part of the carrying trade of the two countries. This ambition was thwarted through the rapid construction of railways in the United States. Then, to make the greater part of Canada's trade pass through Canadian waterways became the underlying principle in Canada's project for transcontinental railways which aim at making traffic flow east and west.

During the early days formidable natural obstacles at Niagara Falls, Sault Ste. Marie and in the rapids along the St. Lawrence stood in the way of continuous navigation. To overcome these, and to retain for the St. Lawrence the traffic which it seemed likely to lose through the building of that short-cut between Lake Erie and New York, the Erie canal, the construction of canals was begun during the opening years of the nineteenth century. These, gradually enlarged and deepened, enable vessels of a draught of fourteen feet to proceed from the head of the Great Lakes to the Atlantic. The most important links in this canal system are the Welland, connecting Lake Erie with Lake Ontario; the Sault Ste. Marie canal, connecting Lake Superior with Lake Huron; and the series of smaller canals along the St. Lawrence. The total canal mileage of Canada is 455 miles, of which 79 miles are along the Great Lakes and the St. Lawrence. On these no tolls are collected; these were abolished in 1903. The total expenditure on canals to March 31, 1923, was $141,390,406. The expenditure on the new Welland ship canal to date has been approximately $40,000,000, and official estimates show that at least as much more will be required to complete it. In the construction of the first Welland, begun in 1823, one gets the key to Canadian transportation policy, which aims at making traffic, originating in Canada, flow through Canadian channels, and also at attracting through the directness of the route, a portion of the traffic originating in the neighbouring states.

Before the days of the railway this great waterway was of much more importance as a general factor in transportation than it is to-day. Not only did it serve a vast Canadian, but also, a vast American territory. With the extension of railways, both in Canada and the United States, it suffered an eclipse; for, while the tonnage carried on it is still large, it is relatively small to that carried by the railways. The volume of traffic through the Canadian canals in 1922 was 10,026,055 net tons, made up as follows:

Sault Ste. Marie	1,709,060	tons
Welland	3,391,419	"
St. Lawrence	4,319,919	"
Other canals	605,657	"

By way of explanation it may be said that since the opening of the new and larger American canal at Sault Ste. Marie in 1915, most of the Canadian grain has been going through it. In 1922 only 24,864,463 bushels of Canadian grain went through the Canadian canal, while 248,712,842 bushels went through the American.

The higher railway freight rates of recent years have made the Great Lakes and the St. Lawrence a more important factor in the movement of grain. During the crop year ending August 31, 1923,

273,801,452 bushels of Canadian grain were carried down the lakes from Fort William and Port Arthur, while another 54,984,745 bushels of American grain were also moved through Canadian lake ports. Bearing in mind that this Canadian crop was raised from only 34,000,000 acres, one gets some idea of the tremendous volume of farm products that will go out by way of the lakes when the vast fertile areas of western Canada are all under cultivation.

The agitation to have the channel of the St. Lawrence river of a uniform depth of thirty feet, in order to make it possible for ocean-going vessels to reach the head of the lakes, is progressing and in time may succeed. Already there is in the St. Lawrence a thirty-foot channel up to Montreal, and as the new Welland ship canal, which is to be completed within three years, is twenty-six feet in depth and provision has been made for its further deepening to thirty feet, there will remain to be deepened only forty-five miles on the upper St. Lawrence.

The waterways of the Dominion are also important as a factor in regulating rates, those charged for traffic by rail being affected strongly by water competition. Not only is this true in eastern Canada; it is true also of British Columbia and Alberta. The construction of the Panama canal, which has brought the Atlantic and the Pacific coasts into easy communication, has added a disturbing factor to the problem of railway rates.

Canadian Railways.—The first railway project of importance was the Grand Trunk Railway, incorporated in 1852 to secure a main line connecting the two Canadas, now Quebec and Ontario. It was built by British capital, with heavy assistance by government, first along the north shore of the St. Lawrence from Montreal to Kingston, and then in 1856 to Toronto. By 1860 the line extended from Rivière du Loup, Quebec, in the east, to Sarnia, Ontario, in the west. At first the traffic was very disappointing, and the Canadian government had to come to the assistance of the system. It was gradually extended through western Ontario, valuable connexions being also secured with Chicago in the west and Portland, Maine, in the east. In the development of Ontario and Quebec the Grand Trunk rendered great service, and its main line from Chicago, through Toronto and Montreal to Portland, will always be one of the main highways of North America.

The Intercolonial Railway connecting Nova Scotia and New Brunswick with Quebec was the second important project. Its need had long been evident; for, as early as in 1839, Lord Durham in his famous Report on British North America had recommended it. Little progress was made until the Civil War in the United States when the Trent Affair in 1861, which brought danger of war with the United

States, showed, for military purposes, the absolute necessity of linking up by rail the several British colonies. The federation of Canada brought reality to the proposal, for the Intercolonial was to begin within six months after the union, a pledge necessary to secure the adhesion of Nova Scotia and New Brunswick. Construction was begun in 1868, and the road was completed to Levis, Que., in 1876. This gave Ontario and Quebec direct connexion through Canadian territory with a Canadian port on the Atlantic coast open all the year round. The route was adopted almost solely for military considerations. It was placed as far as possible from the American frontier without regard to the problem of making the traffic profitable.

The Transcontinentals.—The dream of a railway connecting British Columbia on the Pacific with the colonies in the eastern portion of British North America dates back to the first years of the nineteenth century. Both British and colonial statesmen viewed with apprehension the expansion of the United States to the west and north. As the great plains north of the international boundary could be reached only through Chicago and St. Paul, it was feared that trade and travel might so link the Canadian North West with the western states that its inclusion in the American Union would only be a matter of time. To prevent this a railway across the continent, north of the international boundary, was necessary. By the terms under which British Columbia entered Confederation in 1871 Canada bound itself to commence such a railway within two years and to complete it within ten.

This brought into being the first transcontinental railway, the Canadian Pacific. Construction was actually begun in 1874 as a government undertaking, but, owing to political and other causes, progress was slow. Finally, in 1880, the Canadian government, intent on immediate construction, entered into an agreement with the Canadian Pacific Railway Company to build a line from Lake Nipissing in Ontario to the Pacific coast. The agreement provided for a subsidy of $25,000,000 in money, of 25,000,000 acres of land, for the transfer to the company of the considerable mileage already completed, and for valuable exemptions from taxation. Evidence of the intention to keep Canadian traffic for Canadian transportation interests and to prevent its passing southward to the United States, is to be seen in the prevention for twenty years of a competing line of railway south of the company's main line in the west. The railway was to be completed by the spring of 1891, but the last spike was actually driven in November, 1885. It was originally intended that the main line should run northwest to Edmonton, but finally the route was changed to run through the Kicking Horse pass, much farther south. This decision was

of more far-reaching importance than was apparent at the time. It left the door open to a serious competitor. Later Messrs. Mackenzie and Mann built the Canadian Northern, which followed the valley of the Saskatchewan to Edmonton, and then went through the Yellow Head pass to the Pacific.

While construction from Lake Nipissing to the west was under way, the Canadian Pacific acquired valuable connexions in the eastern provinces. In 1888 it built a short line from Montreal to St. John,

Fig. 16. LOCOMOTIVE, CANADIAN NATIONAL RAILWAYS
One of the sixteen new mountain-type engines built for service between Toronto and the maritime provinces. The largest passenger engine in Canada.

New Brunswick, across the State of Maine. Subsequently it entered Nova Scotia, and then it had a considerable mileage in every province but Prince Edward Island. Extensive connexions in the United States have also made the Canadian Pacific a truly international system. At the end of 1922, it operated 19,603 miles; 14,501 in Canada and 5,102 in the United States. Its gross earnings in that year were

$186,675,035 and its working expenses $150,373,344, so that after deducting fixed charges of $13,348,905, it had a surplus of $22,452,785. Soon after its transcontinental line was opened a steamship service on the Pacific was established. Vessels were also placed in commission on the lakes and on coastal waters, and in 1902 an entrance was made into the North Atlantic field. Now the company operates more than eighty vessels. It also operates a chain of hotels across Canada, and has extensive holdings in the form of mineral and agricultural lands. The total value of its assets at the end of 1922 is given as $1,127,441,150. It is generally considered the world's greatest transportation system by land and water.

The second transcontinental, the Grand Trunk Pacific linked with the National Transcontinental, was begun in 1904. The Grand Trunk Railway had viewed with jealousy the rapid growth of the Canadian Pacific, made possible chiefly through its development of the west, and concluded that, if it was to secure its share of Canadian business, it too must reach the west. It was the general opinion that in the vast west one system should not have a monopoly. The government of the day desired to develop not only the prairie provinces, but also the northern districts of Ontario, Quebec, and British Columbia. A remarkable increase in agricultural production in the prairie provinces was inevitable. One railway, it was thought, could not handle it satisfactorily, and to ensure that the traffic should be carried over Canadian lines and delivered at Canadian ports, a further transcontinental system was desired. The agreement entered into between the government and the Grand Trunk Railway provided that the road should consist of an eastern and a western section. The former, the National Transcontinental, from Moncton, New Brunswick, to Winnipeg, was to be built by the government and leased to the Grand Trunk for fifty years; the western, or Grand Trunk Pacific section, extending from Winnipeg to Prince Rupert, British Columbia, was to be built by the Grand Trunk, assisted by a guarantee of the Canadian government of bonds up to seventy-five per cent. of the cost. For this enterprise the Grand Trunk Railway was primarily responsible, and, in backing it, it assumed a ruinous liability. The combined length of this transcontinental system was 4,708 miles.

The Canadian Northern Railway, Canada's third transcontinental, was the product of the ability and daring of two ambitious railway contractors, Messrs. Mackenzie and Mann. Having built extensively for others, they decided to build for themselves. These operations antedate the construction of the Grand Trunk Pacific. It was in 1896 that Mackenzie and Mann secured their first important line in Manitoba, and they soon acquired others in that province. In 1899

FIG. 17. CANADIAN PACIFIC PASSENGER TRAIN
The "Trans-Canada Limited" in the Rocky Mountains

the Canadian Northern Company was organised and in 1902 a line from Winnipeg to Port Arthur was completed and gave an outlet to the head of the Great Lakes. Then the system spread quickly over the whole of the prairie provinces. It was not, however, until 1902, that Mackenzie and Mann's ambition to possess a transcontinental became apparent. In that year the Canadian Northern was authorized to build from the head of the lakes to Quebec, and to extend to Ottawa and Montreal. The total length of this system was 9,994 miles. Though Mackenzie and Mann had little actual capital, the western provinces were intensely eager for the construction of branch lines, and the company readily secured the assistance of these governments, which, with the Dominion government, supplied guarantees of bonds to the extent of approximately $279,000,000. But even this was not sufficient to finance the system. By 1912 the Canadian Northern was in difficulties, which were greatly increased through the outbreak of war.

Political and Economic Links.—Canadian railway policy has not been determined by economic considerations to the same extent as has railway policy in the United States and in the United Kingdom. Railways came because they were capable of giving better service than could be had from the waterways and waggon roads; but one of the strongest arguments advanced in favour of some of the most important railways was that they would help to maintain British connexion and to promote national unity. The United States was so extending its railway mileage as to involve to Canada the danger that a large part of its traffic would be handled by American roads and there was a fear lest political absorption should follow economic penetration.

Thus from the first there was a clear recognition that, as purely private enterprises, most railways would not be profitable in their early stages, since they must do more than serve the existing economic needs of the country. The Canadian Pacific Railway was built, not so much to meet the needs of the settlers in western Canada, as to induce settlers to enter. As a necessary feature of a great colonisation effort, railways prepared the way for permanent settlement. This is why they received so much government assistance. Up to December 31, 1922, the total amount of aid in loans, subsidies, etc., granted to railways by the federal and provincial governments and municipalities was $722,648,746. In addition they received land grants totalling 46,735,987 acres, while the outstanding railway bonds guaranteed by the federal and provincial governments amounted to $404,601,953. Besides this there had been an expenditure of $415,118,319 on the government railways and the Quebec bridge by which the National Transcontinental crosses from the north to the south bank of the

St. Lawrence. Thus, in the form of loans, cash grants, and other direct expenditures, the Canadian public had provided, up to the end of 1922, $1,137,767,065 and $404,601,953 in bond guarantees, or a total assistance of $1,542,369,018, to say nothing of the value of nearly 47,000,000 acres of land.

Up to a certain point liberal backing of railway projects by public funds was warranted, for if the east had not been linked at an early date with the west by steel, and the prairie provinces had not been fairly well supplied with branch lines, Canada would not occupy the high place industrially and commercially that she does to-day. In 1885, when the Canadian Pacific Railway's main line through the Rockies was completed, there were only 130,000 people in the thousand miles of prairie country, and they produced only grain enough to meet their own needs. But population and grain production increased as railway mileage increased. In 1923 the prairie provinces had about 16,000 miles of railways, their population was over 2,100,000 and they produced over 850,000,000 bushels of grain, of which 450,000,000 bushels were wheat.

A Crisis Precipitated.—Trouble came through failure to distinguish between genuine projects for development and rash speculative ventures. Canada's railway difficulties have been due chiefly to the fact that she unduly backed railway promoters. It is also true that, in doing so, she was influenced more by political pressure than by the promises of promoters. It is well known that the original proposals of the Grand Trunk with respect to its transcontinental extensions, as well as those of the Canadian Northern, were modest compared with those undertakings into which the lines eventually entered. As railway builders and operators the chief men behind these enterprises went contrary to the dictates of their own judgment. But the way, for a time, was made so easy and aid for legitimate extensions was made so conditional on the undertaking of others much less warranted, that the risks, though great, were taken. Sir Henry Drayton, who, as ex-chairman of the Board of Railway Commissioners, is one of the highest Canadian authorities that can be cited, declares that "these systems were, after all, only nominally privately owned". The cost of the Grand Trunk Pacific up to 1916 was $197,129,311, of which $127,939,892 had been obtained from public authority in cash or guaranteed bonds; while the Canadian Northern had similarly obtained $298,253,263 out of a total expenditure of $370,302,451.

The difficulties caused by over-building, inadequate capital, and excessive costs had produced even in 1912 an embarrassing situation, which developed into a grave crisis during the Great War. Owing to the demands of that struggle, the Government, through heavy advances, had to keep the railways operating at whatever cost. The

situation in 1916 was as follows: The Canadian Northern Railway had received directly and indirectly public assistance totalling $298,253,263, in addition to land grants aggregating 6,555,708 acres; the Grand Trunk Pacific had received assistance totalling $114,470,884, while a subsidiary company had outstanding securities, backed by provincial governments, to the value of $13,469,000. The Grand Trunk was virtually bankrupt through its liability with respect to the Grand Trunk Pacific, and apparently the situation was getting worse, for operating costs were rapidly rising.

Government Railway Policy.—The government decided to appoint a Royal Commission of the most capable railway authorities available to enquire into the situation and to suggest a policy. The majority report of Sir Henry Drayton and Sir William Acworth made in 1917 recommended the taking over by the government of the Canadian Northern, the Grand Trunk, and the Grand Trunk Pacific, and that these, with the Canadian Government Railways, should be managed by a board of trustees, incorporated as a railway company, absolutely free from political interference. These recommendations formed the basis of the subsequent government railway policy now in effect.

The outstanding feature of this policy is the application of the principle of corporate management to a government-owned property. By legislation to incorporate the Canadian National Railway Company, all railways owned by the government were brought into one operating unit as a national railway system, and the Governor-in-Council was authorized to entrust to the company the management of any other lines that might be acquired by the government. Power is given to construct new lines approved by the Minister of Railways, as the money for this is authorized by parliament. The number of directors was fixed at not less than five and not more than fifteen, appointed by the Governor-in-Council to hold office from one annual meeting to another, but removable by the Governor-in-Council for due cause. This legislation went into effect in January, 1923, and the management of the Canadian Government Railways, the Canadian Northern, and the Grand Trunk, passed into the hands of the Canadian National Railway Board of ten members, which also operates the Grand Trunk Pacific for a receiver. The total mileage of this system at December 31, 1922, was 22,680 miles, of which 1,696 miles were in the United States. The gross operating revenue in that year was $234,111,090 and operating expenses were $229,917,540, the net revenue before fixed charges being $2,202,782. The fixed charges were $62,454,627 making the grand total deficit $60,251,845.

The Canadian Government Merchant Marine is operated under the direction of the Canadian National Railway Board, which also has the directing of a chain of hotels.

Two Big Consolidations.—Of the total single track railway mileage in Canada amounting to 39,773 miles at December 31, 1922, 33,998 miles were in two systems, the Canadian National Railways and the Canadian Pacific. Thus, in the matter of consolidations, Canada has gone much further than either the United States or the United Kingdom. To this may be attributed largely the efficiency of Canadian roads. The total mileage of all tracks at the foregoing date was 52,273 miles, 2,608 being double track.

The length of lines American owned in Canada at the end of 1922 was 1,398 miles, or equal only to about one-fourth of that of Canadian lines in the United States. Of this, 530 miles belong to the Great Northern, or Hill lines. There was a time when J. J. Hill seemed likely to build an extensive system in western Canada, for ten years ago his roads in Canada had a greater mileage than they have to-day. From the standpoint of traffic and earnings the most important American mileage is that running along the north shore of Lake Erie, forming a short connecting link between Detroit and Buffalo. In 1922 the three American roads operating there moved 11,662,367 tons of freight, out of a total movement of 108,530,518 tons by all roads in Canada. With their very considerable mileage in the United States, Canadian roads now compete strongly for certain American business.

The Railway Commission.—Soon after the appearance of the railways, the legislatures manifested a tendency to control rates, and one finds in some of the early charters, the provision that profits beyond a certain percentage must be accompanied by the reduction of rates. The agreement between the government and the Canadian Pacific Railway also provided that rates should be reduced, if net earnings should exceed ten per cent. In the first general railway Act of 1851, the fixing of rates was left to the carriers, but no undue advantage was to be given to any person, or class, and all rates were to be approved by the Governor-in-Council. The creation of railway-regulating bodies in other countries produced a strong demand for similar control in Canada. By the revision of the Railway Act in 1888 control over rates and regulation generally was placed in the hands of the Railway Committee of the Privy Council. Practice disclosed that this body was unsuited to deal with the many complaints arising. Finally in 1903 machinery for a Board of Railway Commissioners was created and it was set up in the following year. Three commissioners, appointed by the Governor-in-Council, were provided for, and in 1908 the number was increased to six. The Board is organised as a court, and its decision on a question of fact is final; there is, however, an appeal to the Supreme Court on a question of law. Its jurisdiction is very wide. Its most important function is the control of rates, decisions being

subject to an appeal to the Governor-in-Council, who has also power to review or vary the action of the Board. The retention of this power is chiefly a mere assertion of the principle that the government cannot divest itself of responsibility for a decision that may vitally affect the business life of the country. The power is very rarely exercised. But the jurisdiction of the Board extends also to engineering and management, to the supervision, for instance, of the location of lines with their inspection before use; to the safety and suitability of lines operated; to the classification of freight, to tariffs, and to the investigation and remedying of complaints under these headings. The Board stands high in public estimation. Its decisions have been based on broad principles of policy and have given general satisfaction.

Influenced by the example of control exercised by the states of the American Union, some of the provinces, at times, have provided for control of rates in the case of companies incorporated under provincial laws, or that have received provincial assistance. Such attempts have not generally been effective, even when agreed to by the companies. These have come under federal control through being declared works for the general advantage of Canada.

Other Rate-controlling Factors.—Effective as has been the control of rates by the Board of Railway Commissioners, a hardly less important factor in reductions have been agreements entered into between railways and governments. Of these the most important is the Crow's Nest Pass agreement of 1897 between the Dominion government and the Canadian Pacific. In return for a cash subsidy of $3,381,000 for the building of a line through the Crow's Nest pass in western Canada that company agreed to grant a stated reduction in the rates on grain and on flour, moving from points in the prairie provinces eastward, and to reduce, also, the rates on the westward movement of certain commodities used chiefly by settlers. Because of the greatly increased cost of operating during the Great War, this scale was, in 1918, suspended by the government, under the authority of the War Measures Act; but, in so far as the rates on grain are concerned, the scale was restored again in 1922. The effectiveness of this agreement is evident from the fact that in 1923 over 90 per cent. of the grain of western Canada was moved on rates based on the low operating costs of twenty-six years ago. In 1901, the Canadian Northern Railway, in return for assistance granted by the Manitoba government for its line from Winnipeg to Port Arthur, agreed to provincial control of rates. This involved certain reductions which the Canadian Pacific had to meet. As has already been pointed out, in the eastern provinces and in British Columbia and Alberta rates are affected by water competition, while, along the boundary line, there is the ever present factor of American competition.

For some years there had been conducted an agitation to bring freight rates on inland waters under the control of a regulating body. This was brought to a head through the unusually high charges on the movement of grain during a portion of the latter part of the season of 1922. In response to a general demand for action, a Royal Commission was appointed to enquire into the situation. Acting on the basis of its report, the Inland Water Freight Rates Act of 1923 was passed, which requires grain carriers, operating between ports at the head of the Great Lakes and any port in Canada or the United States, to file with the Board of Grain Commissioners a tariff of rates. The Board is also empowered to fix maximum rates.

Electric Railways.—In Canada electric railways have been confined chiefly to cities and to inter-urban districts. The first electric street cars began operations in 1887. Success having been demonstrated, other systems were soon built and now almost all urban communities use electricity. Recently inter-urban mileage has been added chiefly in south-western Ontario and in British Columbia. The tendency is to increase the mileage wherever electrical power can be secured. Electrification of steam roads has not proceeded very rapidly, owing to the high cost of construction and of the replacement of equipment. In 1901, 675 miles of electric railway were in operation, carrying 120,934,656 passengers, and 287,926 tons of freight. In 1922 the mileage had increased to 1,725; the passengers to 738,998,949 and the freight to 2,445,425 tons. The capital investment was $186,519,000. Some of the lines in Ontario are operated by the Canadian National Railways.

Motor Trucks.—Since, in 1922, Canada had 513,821 licensed motor vehicles, being second only to the United States in such use, in proportion to population, it might seem that motor busses and trucks would be an important factor in transportation. But such is not the case. It is difficult to get exact figures, for two of the smaller provinces do not differentiate between the licensing of trucks and of ordinary cars. In 1922, in the other seven provinces, the number of truck licenses issued was 37,610, of which 24,164 were in Ontario. This indicates that the total number of trucks in all Canada at that date was not much more than 40,000. In southwestern Ontario, where roads suitable for heavy motor traffic are general, and the milder nature of the winter does not seriously affect their operation all the year round, the motor truck is a factor in transportation; but this is a very small part of Canada.[1]

[1]For bibliography see appendix.

CANADA'S FOREIGN TRADE

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It is no easy task to give a bird's-eye view of Canada's foreign trade without wearying the reader with long and complicated tables of figures. Such figures, however delightful to the statistician, are generally somewhat disconcerting to one who, although desirous of exact knowledge on the subject, does not care to be burdened with the minutiae of trade returns, nor involved with the problems of trade balances. The following little study, therefore, will be confined almost wholly to a broad, general survey of the underlying facts connected with Canadian commerce.

In the first place it must be understood that foreign trade is the very life blood of the Dominion. As yet a young country, whose capacity to absorb population is far from saturation point, Canada has not yet developed a home market that can use all, or anywhere near all, her own products. This is the more apparent when we remember that Canada's production is very largely confined to raw materials, grain, dairy products, lumber, pulp and paper, minerals, etc., whose volume is so great that the manufacturing resources of the Dominion can hardly begin to cope with the vast output. In this she is following in the steps of the United States, and doubtless, as Canada's manufacturing capacity increases like that of the United States, this tremendous volume of foreign trade will begin to be absorbed in local consumption; that day, however, is yet far off.

The first fact, and it must be admitted a very astonishing one, is that with a population of approximately nine millions (8,788,000 in 1920) her exports for the 12 months ending November 1923 reached $1,015,000,000, and her imports $908,000,000, which gives, roughly, a per capita import trade of $112, and export trade of $101, or a total per capita external trade of $213.. This is an amazing total, but while Canadian trade is picking up in a very marked way since the great depression of 1920-21, yet the total external trade per head was $300 in 1918. These are impressive totals, but dwindle to insignificance when we compare them with a per capita trade of $600 in the case of the Falkland islands, and $500 for that of the French islands of St. Pierre and Miquelon. It is to be expected that this per capita foreign

trade will gradually shrink as Canada absorbs more of her own products and relies less on imported manufactured articles.

Distribution of Trade.—The following table indicating the markets for Canadian exports tells its own tale:

Destination of Canadian Export

Year	United Kingdom	United States	All other countries
1896	57.2 per cent.	34.4 per cent.	8.4 per cent.
1906	54.1 " "	35.5 " "	10.4 " "
1914	49.9 " "	37.9 " "	13.2 " "
1922	40.4 " "	39.5 " "	20.1 " "

The tendencies revealed by the above table are very marked: a steady decline in the proportion of Canadian exports going to the United Kingdom, a less marked rise in the proportion going to the United States, and a very notable increase in those going to other countries. The conclusions that may be drawn from these figures are varied, but, taking them from the broadest view, it is evident that Canada is entering more and more into world trade, and is not so dependent on the British market as heretofore. This movement, on the whole, is undoubtedly a healthy one from the Canadian point of view. There is no doubt that this result is attributable in no small degree to the activities of the Department of Trade and Commerce, which, since the war, has been bending every effort to extend Canada's world trade, and through its system of Trade Commissioners all over the world is doing much to introduce Canadian merchandise into new markets.

Turning now to imports, we find the following:

Sources of Canadian Imports

Year	From the United Kingdom	From the United States	From all other countries
1896	31.2 per cent.	50.8 per cent.	18.0 per cent.
1906	24.4 " "	59.6 " "	16.0 " "
1914	21.4 " "	64.0 " "	14.6 " "
1922	15.7 " "	69.0 " "	15.3 " "

The tendencies here are somewhat startling, and perhaps from the imperial point of view a trifle disturbing. A glance will show that in 26 years the proportion coming from the United Kingdom has been halved almost exactly, the proportion from all other countries has dropped a trifle, but that coming from the United States has increased 36 per cent. The reasons for this are not very hard to find. The United States, simply from the fact of contiguity, is Canada's natural market both for buying and selling, and as the United States becomes more and more an exporting country, as it inevitably must with its

colossal industrial development, it is not to be wondered at that Canada will buy more and more from her nearest neighbour. It is still too early to foresee with any accuracy the outcome of the heavy increases in import duties imposed by the United States by what is known as the Fordney Tariff, which must affect both imports and exports to and from Canada. Obviously it is also impossible to say anything of the outcome of the proposed preferential duties discussed at the last Imperial Conference.

Classes of Commodities Exported.—Of the total of all exports in 1922 of over seven hundred and forty million dollars, 44 per cent. were raw materials, 40 per cent. were wholly manufactured, and 16 per cent. were partly manufactured. Of the raw materials, 50 per cent. went to the United Kingdom; 30 per cent. went to the United States; and 20 per cent. to all other countries. This percentage is quite understandable, since the United States abounds with raw materials itself without having to rely very much on the Canadian supply, while the United Kingdom must buy much from abroad. Of wholly manufactured articles, 38 per cent. went to the United Kingdom; 36 per cent. to the United States; and 26 per cent. to all other countries. Of partly manufactured articles, 19 per cent. went to the United Kingdom; 69 per cent. to the United States; and 12 per cent. to all other countries. The striking difference between the exports of partly manufactured articles to the United States and to the United Kingdom, much greater to the former than to the latter, can be explained in very large degree by the tremendous export of wood, pulp, and paper from Canada to the United States. The balance of non-ferrous metals (*e.g.*, copper, gold, silver) and non-metallic minerals, is also heavily in favour of the American market.

Dividing these exports into their most important classes we find the following in 1922:

PERCENTAGE DISTRIBUTION OF EXPORTS

Vegetable products	43 per cent.
Wood and paper	24 " "
Animal products	18 " "
All other	15 " "

It is quite needless to remark here upon the preponderating importance of vegetable products, the Canadian wheat crop accounting for that very easily.

The following table exhibits a few of the more important items of export for the year 1922:

VALUE OF EXPORTS IN DOLLARS TO NEAREST MILLION, 1922

Wheat	180
Logs and sawmill products	71
Paper	70
Meats	30
Fishery products	29
Live cattle	8

Exports of Manufactures.—The advent of the war and the call for munitions from Canada gave an enormous impetus to the export of wholly manufactured articles. In the last decennium of the nineteenth century manufactured articles amounted to barely eight per cent. of the entire exports. At the outbreak of war the proportion had increased to between 13 and 14 per cent. In 1922 manufactured articles amounted to 40 per cent. of the total, a truly remarkable increase. There is no doubt that the war gave a wonderful impetus to Canadian manufacturing enterprise, and there seems no reason to suppose that this proportion will be receded from in the future, and in fact there is every possibility that it will be exceeded.

Canadian Imports.—The following table represents the relative proportions of Canada's chief articles of import:

CANADIAN IMPORTS IN YEAR 1922

Iron, steel, and other metals	21 per cent.
Coal	8 " "
Textiles, cotton, wool, silk	16 " "
Sugar, fruits, grain	10 " "
Chemicals, oils, etc.	9 " "
All others	36 " "
	100

The above table exhibits in a somewhat striking manner the nature of Canada's requirements from abroad. In the first place Canada needs a great quantity of iron and steel products, simply from the fact that her own deposits of iron ore have not yet been fully developed. Whether northern Ontario will in the future give to the busy manufacturing industries of that province sufficient iron for its very considerable needs has yet to be seen. Canada is richly supplied with coal both in the east and in the west, but the central region, particularly Ontario, is dependent on Pennsylvania for its supplies. Whether Welsh coal may be imported profitably is still uncertain, and even more uncertain is the possibility of delivering Alberta coal in Ontario at a competitive price with Pennsylvanian.

With regard to the item of textiles, Canada must, of course, import all her cotton and silk and a very large proportion of her wool, an important element of clothing in her cold winters. It is notable that sugar constitutes a heavy item of import, the value amounting to

$37,500,000 in 1922. Probably the United States and Canada are the heaviest consumers of sugar in all its different forms, the astonishing consumption of ice cream and candies accounting for much of this. It is notable that the consumption of sugar in both countries is steadily mounting, perhaps a consequence of prohibition, perhaps a fairly good measure of increasing prosperity, since every nation uses as much sugar as it can afford.

Among the miscellaneous items are "sundry beverages", $30,000,000, a fairly heavy bill, but the per capita consumption of tea in Canada is high, not quite equalling that of Australia, but leading to an annual bill of $10,000,000.

Balance of Trade.—Since 1867 Canada has enjoyed a balance of trade in her favour during only ten years, five of which were war years and remarkable for very heavy exports of munitions. The Dominion, therefore, has presented the curious spectacle of having had an unfavourable balance for about 45 years, and seemingly of having flourished in it. The reason for this apparent phenomenon is very easy to find; it lies in the fact that Canada has been importing great quantities of capital goods for her own upbuilding. With undeveloped manufactures in the past she was forced to import most if not all the machinery she required for the expansion of her industries. The amount of foreign and British capital invested in Canada is very great, having been computed by competent authorities at about five and a quarter billion dollars, of which Great Britain is responsible for some two and three-quarter billion dollars, the United States for another two and a half billion dollars, the small balance being made up by other countries.

An analysis of the balance of trade between Canada and Great Britain, the United States, and other countries shows that since the beginning of the century Canada has invariably exported to Great Britain more than she received from that source. On the other hand the exact reverse has always been the case in her trade with the United States, in which country Canada buys much more than she sells. Thus from 1900 to 1914, Canada was a creditor of Great Britain for $819,000,000 and a debtor to the United States for more than $1,500,000,000, and a debtor to other foreign countries for about $300,000,000. During the war period the situation remained the same with regard to Great Britain and the United States, but the debit balance to other countries was turned into a credit one.

It is illuminating to note how, with the increased investment of American capital, an increased proportion of Canadian purchases in the United States has followed. If, as we may anticipate, the investment of American capital continues to grow, and that of capital from

the United Kingdom, if not actually to shrink, at least not to increase as quickly as that from the United States, we may anticipate a still larger proportion of Canada's purchases being made in the United States.

In conclusion, if we look at the whole situation calmly in the light of such statistics as are available, we are forced to the conclusion that Canada's trade is turning more and more to the south and away from Great Britain. Such a tendency seems quite inevitable. The United States, with a population fast approaching 110,000,000, must provide Canada's greatest and most profitable market, both for buying and selling; the force of attraction is rendered irresistible by propinquity. Canada offers a very promising field for American investment, and the United States is very rapidly increasing its capital holdings in Canada. This fact alone will warrant an increasing trade north and south; unless, of course, by some scheme of imperial preference this tendency is arrested, and even then it is hard to see how these strong forces are going to be turned from their natural functioning.

BANKING IN CANADA

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In her system of banking Canada is one of the very few fortunate countries in which this has gradually developed without departing from quite sound original principles. It has been subjected to no revolutionary changes, the present Bank Act being the natural evolution which experience and larger needs have required. The necessities of government finance have rarely disturbed its service as a handmaid to the commerce of the country, and while in each decennial revision of the Act public opinion has freely expressed itself, few, if any, of the unsound views which inevitably arise at such a time, have thus far made an impression upon the Act itself.

History.—In the history of banking, Canada is not, as might be supposed, one of the new countries of the world. Following the systems of barter established by law, the history of currency in the old Canada, which preceded Confederation, begins in 1685 with the issue by the French colony of one of the earliest forms of fiat paper money in the western half of the world. Indeed, this ingenious experiment is supposed to have inspired the British colonists of Massachusetts to venture upon the same kind of money. The general use later of such paper issues by all the colonial governments was naturally followed by the famous Continental currency of the Revolution. It was because none of this paper money in its later issues was paid in full, and much of it was not redeemed in any manner, that the people of old Canada were so wary and incredulous when, after the establishment of representative government, efforts were unsuccessfully made in 1792, 1807, and 1808 to obtain the authority of Parliament for banks of issue.

In order to pay the expenses of the war, issues of fiat money for which the credit of Great Britain was pledged were made from 1812 to 1814 through the Army Bill office, and these were redeemed during the ensuing four or five years. It was not until after this, in 1817 and 1818, that the first banks were created in Lower Canada, now Quebec. They were at first private corporations, but obtained charters in 1821 to which the Royal Assent (then necessary) was given in 1822. In 1817 the provincial parliament of Upper Canada (now Ontario) was also

[1]*Obit.* March 27, 1924.

asked to incorporate a bank, and consented, the Lieutenant-Governor, however, reserving his signature for the Royal Assent, which was given in 1821. There was a dispute between two sections of Upper Canada over this charter, and eventually it took shape as a bank in which the provincial government owned about one-fourth of the stock, with the right to name four out of fifteen directors; the only instance, fortunately, of state ownership in our banking history.

Turning to the maritime provinces, which became a part of the present Canada in 1867, we find that in Nova Scotia unsuccessful efforts were made in 1801 and 1811 to form banks. Until 1812 the provincial government often paid its debts by issues of treasury notes or warrants, bearing interest and not re-issuable, but in that year it began to issue notes *not* bearing interest and *re-issuable.* From this time until Confederation (1867) the province continued to issue treasury notes, sometimes redeemable in gold and sometimes not, having finally in circulation £605,859 (Halifax currency), not a large sum, but, unfortunately, more than the new Dominion government felt able to redeem in cash. This was the beginning of the present legal tender issues, the least defensible feature in Canadian currency and banking. Early in 1820 Royal Assent was given to a charter for a bank in New Brunswick, but, despite the attempts early in the century and doubtless because of the existence of the government treasury notes, no bank was started in Nova Scotia until 1825. This was a private bank, and remained so until 1872. The first joint-stock bank was not created until 1832.

It may safely be said that the three charters granted in Lower Canada, practically alike, are the substructure on which all subsequent improvements have been built, and that no very radical changes have been at any time necessary. Indeed, there are many provisions in these charters which were subsequently included, almost unchanged, in the general Banking Act.

After tentative legislation in 1867 and 1870, the first general Bank Act of the new Dominion of Canada was passed in 1871 (34 Vic., c. V.). As the charters of existing banks expired they were renewed under the Dominion Act. The first Act extended all charters for ten years, which practice has been followed thus far. The main revisions have been five in number and took place in 1880, 1890, 1900, 1913, and 1923. Of these, the second and fourth introduced the most important changes. In addition, there have been occasional amendments, usually of minor importance, between times. The Act now in force is that enacted in 1923 and known as 13-14 George V, Chapter 32.

Bank Act.—It is impossible in this brief article to do more than refer to a few leading features of the Act.

The charters of all banks are alike, expire at one moment, and are renewable for only ten years. This was at first the natural result

of the confederation of the British North American provinces, the creation of a general bank Act and the desire to test its qualities and powers before settling down to one system. At first, bankers looked forward to a longer period when this time arrived, but a decennial revision has now become an accepted practice. It at least ensures a complete review of the principles underlying the Act, and of the details connected with the working of it, once in ten years. During the session of parliament preceding the date of the expiry of the charters, the system comes under attack from the demagogue, the bank-hater, the honest but inexperienced citizen who writes letters to the press, sometimes the press itself; in fact it comes under all the kinds of attack to which institutions possessing a franchise granted by the people are subject when they come before the public to answer for their stewardship. But, while resisting the attacks of ignorance, bankers are, of course, called upon to answer such just criticisms as may arise from the existence of defects in the system made evident by the experience of time. On the whole, the product of the various discussions in the Banking and Commerce Committees has been a banking Act improved in many respects by the exchange of opinion between the bankers and the public.

A bank cannot be created in Canada unless actual subscriptions of capital have been made to the extent of $500,000 and actual "payments in money on account thereof" to the extent of $250,000, which sum must be deposited with the Minister of Finance before the certificate is issued authorizing the bank to transact business. There are other safeguards, all the result of a past history showing the danger of creating weak banks with neither capital nor experience with which to meet the inevitable dangers of a new venture. There is, however, always present a sentiment against any obstacles to what is called freedom in banking, notwithstanding repeated and ample evidence in many countries of the greater loss to both depositors and shareholders where small banks exist. The "paid-up" capital of existing banks in Canada on November 30, 1923 ranges from $500,000 to $27,250,000 with a total for the sixteen banks of $123,409,130 and reserve funds of $123,625,000, nine banks showing reserve funds equal to or exceeding the paid-up capital.

In Canada, as in the United States, shareholders in banks are subject to what is known as "double liability". For the benefit of readers who may not understand the phrase, we will quote the section in full:

"In the event of the property and assets of the bank being insufficient to pay its debts and liabilities, each shareholder of the bank shall be liable for the deficiency to an amount equal to the par value of the shares held by him, in addition to any amount not paid up on such shares."

All transfers of shares must be accepted by the transferee. No transfers within 60 days before failure avoid the double liability of the transferor, but he may collect, if he can, from the transferee. The fact that the capital is large and that the banks have many branches and are of a more or less national character, causes the stock to be widely held. In the largest banks the share list numbers from 7,000 to 8,000 names. No legislative checks, or even severe public scrutiny, will altogether prevent bad banking, but our banking history, since the confederation of the old provinces into the Dominion in 1867, shows that the double liability has been a most substantial asset, and has done much towards enabling liquidated banks to pay in full.

To most people the sections referring to the note-issuing power of banks are doubtless the most interesting in the Act. In Canada, we began with the very simple and obvious theory that, without the existence of laws to the contrary, an individual had the right to issue his promise to pay in any form, the only deterrent to the exercise of such a luxury being the difficulty of inducing anyone to accept it in payment. For a considerable period, the law did not interfere with the exercise of this power, and in collections devoted to historical objects many curious specimens of money issued by private business as well as private banking firms may be found. Indeed, in refusing for such a long time to grant the privilege to an incorporated bank, the first legislature of Lower Canada was, doubtless, moved only by the fear that, because of the express authority of law, the bank might be able to float an undue amount of such money. In the present Act, the mere right, apart from subsequent qualifications, is expressed in a few simple words: "The bank may issue and reissue its notes payable to bearer on demand and intended for circulation." The qualifications accompanying this general power have grown from time to time until we believe that Canada now possesses the best currency medium in the world. The main qualifications are as follows:

1. Bank-note issues must not exceed the aggregate of the unimpaired paid-up capital of a bank and of the amount of gold coin or Dominion notes held for it in the Central Gold Reserve.

2. During the crop-moving season, however, a bank may issue additional notes up to fifteen per cent. of the combined unimpaired paid-up capital and rest or reserve fund, after giving notice to the Minister of Finance of its intention to do so, for which privilege it shall pay interest at such rate, not exceeding five per cent. per annum, as the Minister may fix.

3. A bank must not issue notes in denominations smaller than five dollars, or for any sum not a multiple of five dollars.

4. No bank shall pledge, assign, or hypothecate its notes and no loan made on such security shall be recoverable from the bank or its assets.

In Canada, as in the United States and elsewhere since the "Great War", the resulting difference in business transactions, after cheques and all other modern instruments of credit have been used, is almost entirely paid in paper money. It is, therefore, of the greatest importance that the amount of this paper money existing at any one time shall be as nearly as possible just sufficient for the purpose. That is, that there shall be a power to issue such money when it is required, and also a power to force it back for redemption when it is not required.

It may, therefore, we think, be safely asserted, first, that there should be as complete a relation as possible between the currency requirements of trade and whatever are the causes which bring about the issue of paper money; and secondly, as it is quite as necessary that no over-issue should be possible as that the supply of currency should be adequate, there should be a similar relation between the requirements of trade and the causes which *force notes back* for redemption.

No bank dares to issue notes without reference to its power to redeem any more than a solvent merchant dares to give promissory notes without reference to his ability to pay. The presentation for actual redemption of every note not required for purposes of trade is assured by the fact that every bank seeks by the activity of its own business to keep out its own notes, and therefore sends back daily for redemption the notes of all other banks. This great feature in the Canadian system is generally overlooked, but it is because of this actual daily redemption that there has never been any serious inflation of the currency. Trade, of course, becomes inflated, and the currency will follow trade, but that is a very different thing from the existence in a country of a great volume of paper money not required by trade. In the older countries of the world it may be sufficient if the volume of currency rises and falls with the general course of trade over a series of years, and without reference to the fluctuations within the twelve months of the year. In North America it is not enough that the volume of currency should rise and fall merely from year to year.

Since 1880 note issues have been a prior lien upon the estate of a bank, prior even to a debt due to the Crown. At the revision of the Act in 1890 it was recognised that there were still two minor though serious defects in the system. It was frequently alleged by those who admired the National Bank Act of the United States that, while the currency created by it might not be elastic, the notes could not for any reason fail to be paid in full, or to circulate without discount throughout the entire area of the United States, while in Canada no similar boast

could be made. The area of Canada is enormous relatively to population, and the notes of banks in one province certainly passed at a discount in some of the others, a recurrence in a less aggravated form of a defect in the old State-bank issues of the United States. And, while it might be confidently asserted that all bank issues secured by being a first lien on the estate of the banks would eventually be paid in full, it was nevertheless true that, because of doubt and delay, the notes of a suspended bank might fall to a discount for the time being. To meet these two defects, the bankers at this time proposed the following new features which were adopted by the government:

1. To avoid discount at the moment of suspension of a bank, either because of delay in the payment of the note issue by the liquidator, or of doubt as to ultimate payment, each bank is obliged to keep in the hands of the government a deposit equal to five per cent. on its average circulation, the average being taken from the maximum circulation of each bank in each month of the year. This is called the Bank Circulation Redemption Fund, and should any liquidator fail to redeem the notes of a failed bank, recourse may be had to the entire fund if necessary. As a matter of fact, liquidators are almost invariably able to redeem the note issues as they are presented, but, in order that all solvent banks may accept without loss the notes of an insolvent bank, these notes bear five per cent. interest from the date of suspension to the date of the liquidator's announcement that he is ready to redeem.

2. To avoid discount for geographical reasons, each bank is obliged to arrange for the redemption of its notes in certain named commercial centres throughout the Dominion.

That our bank-notes are abundantly secured, so far as the public is concerned, seems evident from the fact that a note circulation at December 31, 1922, of $176,201,351 was in effect secured by a prior lien on total assets of $2,618,638,104, to which must be added the double liability of the shareholders on the capital stock of the banks, making a total of $2,743,930,038. That the banks are not likely ever to lose a dollar by the system of guaranteeing each other's notes seems quite clear. Daily redemption and other features in the Act make it difficult to create a forced circulation, and, although we have had several fraudulent bank failures, there has never been a case where the assets on which we had the first claim did not easily protect us.

In the revision of the Act in 1913 the Central Gold Reserve was established and banks were authorized to enlarge their note issues to the extent of the "amount of current gold coin and of Dominion notes held for the bank in the Central Gold Reserves".

In earlier days when the average capital of each bank was small, we could count upon the necessity of an increased issue of a bank's

notes, which always bear a clear relation to the volume of its business, being met by increasing the paid-up capital correspondingly. But as the average capital of the banks increased, and the average dividend did also, and the length of time of each issue of a note lessened by the improvement of transportation, and taxation grew, banks were much less willing to take on new capital for the value of the note-issuing privilege alone. They, however, fully realised their obligation to provide the currency necessary for the business of the country, and thus the arrangement was authorized under which they can issue against gold or Dominion notes deposited with the trustees of the Central Gold Reserve.

In Canada gold is not used as currency, but as a bank reserve. Of the legal tenders issued by the government, over seven-eighths are held as bank reserves, while the remainder are the change-making notes—that is, those smaller than five dollars. Hence the business of the country, apart from cheques and other credit instruments, is done with bank notes, and small legal tenders. As Canada is a country with wide fluctuations in the volume of business during the year, owing to crop moving and to marked variation in the seasons, great flexibility of the currency is needed. We find that between the low average of the circulation during about eight months of each year and the maximum attained at the busiest period of the autumn and winter there is a wide difference, the movement upward in the autumn and downward in the spring being so sudden, that without the power in the banks to issue, serious stringency must result in the autumn, and without the force which brings about redemption in the spring, there must be plethora. As a matter of fact the Canadian system works automatically, and there is always enough currency and never too much. The range of the bank-note circulation during each of the last five pre-war years, and the degree in which the bank-note circulation has met the expanding and subsequent contracting needs of business in general during the last few years is shown by the following table:

RANGE OF BANK NOTE CIRCULATION IN CANADA

	Lowest	Highest	Percentage of Difference
1909	$ 65,819,067	$ 89,633,549	36.2
1910	73,378,676	95,992,866	30.8
1911	77,110,971	105,855,021	37.3
1912	88,065,521	115,473,098	31.1
1913	94,575,644	119,497,321	26.4
....	....	....	....
1918	171,674,464	234,982,978	36.9
1919	203,424,472	237,547,162	16.7
1920	216,691,916	249,165,707	15.0
1921	181,953,001	207,417,917	14.0
1922	155,652,145	178,623,690	14.7

The following figures of our total bank note issues over a series of years afford an illustration of the growth of Canada:

Bank Note Issues over a Series of Years

Date	Amount
Dec. 31st, 1867	$ 8,851,451
Dec. 31st, 1870	18,526,212
Dec. 31st, 1880	27,328,358
Dec. 31st, 1890	35,006,274
Dec. 31st, 1900	50,758,246
Dec. 31st, 1920	228,758,587
Dec. 31st, 1922	176,201,351

There are various misconceptions about the power of note issue granted to the banks, which it seems desirable to dispel. Many think that the money lent by a bank comes largely from its note issue, and upon the notion that each dollar of note issue is thus lent, build up a vast imaginary profit. The money lent by one of the larger banks comes from its deposits, its share capital and rest fund, and its note issue in the proportion of 86 cents from deposits, eight cents from shareholders' funds, and six cents from note issue, for each dollar lent.

In early days, when money was always scarce and roads and all transportation difficult, the note issue was much more valuable to a bank than it is now. To-day the larger banks hold more actual cash than their note issues and paid-up capital combined. One of the most important elements in the note issue is that it enables hundreds of branches to be opened because the till money required can be so supplied. Without the saving of the interest which would otherwise be a charge on such branches, they could not exist.

Space does not permit of dealing as fully with other features of the Bank Act as with the note-issuing power. The depositor is, in our opinion, much safer because of the few large banks with ample capital and large reserves than in a country with a great number of small local banks, and the actual experience for many years confirms such a view. The borrower is better served also than in such countries. The deposits of those who save in any part of Canada can be made available for those who borrow in any other part in a manner as nearly perfect as could be imagined.

The branch system has always existed in Canada and has now reached a development which affords more bank establishments relative to population than the systems of banking in the United States. The seventeen Canadian chartered banks at December 31st, 1922, had about 4,671 branches of which 4,472 were in Canada.

Finance Act.—Little if anything in the financial history of Canada is more creditable than the Finance Act of 1914. The bankers in response to the call of the Finance Minister, met him in Ottawa on the

3rd of August, and the discussion resulted in the issue that night of the Order-in-Council which the Finance Act was passed to confirm. The Act is intended to meet an emergency arising from "war, invasion, riot, or insurrection, real or apprehended, and in case of any *real or apprehended financial crisis*", and as it operates by proclamation in whole or in part, there seems to be no objection to its remaining on the statute book.

The Act (1) authorized the Minister of Finance to make advances to the banks in the form of Dominion notes, against securities satisfactory to the Treasury Board; (2) it authorized the banks to pay their debts in their own notes, provided such notes were not issued in excess of the bank's authority under the Bank and the Finance Acts; (3) it made more elastic the use of emergency circulation already permitted by the Bank Act; (4) it suspended the redemption in gold of Dominion notes; and (5) it made a general moratorium possible at any time by mere proclamation.

The Dominion notes or legal tenders issued during the war were thus quite different from the fiat money of many countries. They were based upon securities pledged by the borrower, they were used practically by the banks only, and became the basis for enlarged issues of bank notes under the regulations of the Central Gold Reserve. Now that the war is over it can be seen that there was no inflation of the currency as such, but merely that larger use of currency which accompanies an increase in the volume of commodities and of prices; and now that such expansion of trade has disappeared, a contraction of our currency has followed without any disturbance whatever.

A prominent feature of the Finance Act was the power given to the banks to pay all liabilities in their own notes. By many this is supposed to have been a measure entirely in aid of the banks, but its main objects were for the preservation of national finance. Individuals here as in other countries had to be prevented from hoarding gold, and particularly from exporting gold, and if for no other reason the power referred to had to be given to the banks. But the banks had no power to issue currency except under the Bank and the Finance Acts, and, when their respective obligations reached the clearing house, had to pay them in Dominion notes or their equivalent. There was no fiat money of the kind issued in some countries to aid the financial position.

The power to proclaim a moratorium was never exercised.

We must hope that a return to a gold basis will not be much longer delayed, but unless something equally valuable takes its place, the power to make advances to the banks should remain in force for the present. We have always to meet the financial effect of the long winter over which we have to carry our cereal products, and the rapid rush

beforehand to avoid this, and there are other movements of commodities with somewhat similar difficulties. When the pound sterling was on a gold basis the banks could draw on London against their credit or their securities, and thus find the means to pay foreign debts as against the later arrival in Europe of these products, but just now, they cannot do this without a risk in exchange rates which they could not afford to take. Many, of course, desire to see a bank of re-discount established, but this is a much more difficult and dangerous system unless guarded by restraints not present in recent examples of such banking. Without severe restrictions and a loss of profit to all who require such aid, a system of re-discounts may become the most active instrument of inflation.

CANADIAN MANUFACTURES

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The history of manufacturing in Canada dates from the beginning of the seventeenth century when the early French settlers in the Province of Quebec began a few small local industries such as shoemaking. The work was done by hand. Machinery was unknown.

From that time until the confederation of the provinces of Canada in 1867, manufacturing made little progress. The various British colonies possessed comparatively few industries and obtained most of their manufactured goods from the United States and Europe in exchange for lumber, grain, furs, and other raw materials.

At the time of Confederation, the total value of goods manufactured in Canada was less than $250,000,000 per year. Even after Confederation manufacturing grew very slowly, and in 1880 the annual production was about $300,000,000.

In 1878, Canada adopted the National Policy which provided tariff protection for Canadian industry. From that time until the present, manufacturing has developed remarkably in Canada. The latest government statistics estimate the value of manufactured goods produced annually in Canada at about $4,000,000,000, or sixteen times the value of the output at the time of Confederation. The official statistics of manufactures by provinces are as follows:

Statistics of Canadian Manufactures, 1920

Province	No. of establishments	Capital	No. of employees	Value of products
Nova Scotia	2,440	$ 148,194,000	28,342	$ 163,059,000
Prince Edward Island	525	3,153,000	1,623	6,982,000
New Brunswick	1,560	109,393,000	21,085	113,628,000
Quebec	11,518	1,030,570,000	205,107	1,120,263,000
Ontario	17,538	1,703,454,000	334,192	2,010,484,000
Manitoba	1,858	118,462,000	28,687	175,495,000
Saskatchewan	2,298	40,019,000	10,394	72,390,000
Alberta	1,983	60,391,000	14,316	98,245,000
British Columbia	2,673	224,423,000	40,892	258,545,000
Yukon	13	1,468,000	60	280,000
Total for Canada	42,406	$3,439,527,000	684,698	$4,019,371,000

Canadian manufacturing covers a wide field, and includes nearly all the manufactured articles used in the country. Manufacturing is classified by groups, as follows:

CLASSIFICATION OF MANUFACTURES IN INDUSTRIAL GROUPS, 1920

Industrial Groups	No. of establishments	Capital	Per cent. of total capital
Vegetable products	4,233	$396,000,000	11.5
Animal products	4,823	222,000,000	6.5
Textile products	4,528	322,000,000	9.4
Wood and paper products	7,867	772,000,000	22.4
Iron and steel products	1,690	643,000,000	18.7
Non-ferrous metal products	324	109,000,000	3.2
Non-metallic mineral products	866	144,000,000	4.2
Chemical and allied products	464	122,000,000	3.5
Miscellaneous industries	1,421	500,000,000	14.5
Construction, hand trades, and repairs	16,190	209,000,000	6.1
Total	42,406	$3,439,000,000	100.0

Industrial Groups	Value of products	Per cent. of total value of output
Vegetable products	$775,000,000	19.3
Animal products	553,000,000	13.8
Textile products	466,000,000	11.6
Wood and paper products	724,000,000	18.0
Iron and steel products	715,000,000	17.8
Non-ferrous metal products	101,000,000	2.5
Non-metallic mineral products	129,000,000	3.2
Chemical and allied products	128,000,000	3.2
Miscellaneous industries	120,000,000	3.0
Construction, hand trades, and repairs	308,000,000	7.6
Total	$4,019,000,000	100.0

As this table shows, the three leading groups are vegetable products, which include such articles as flour, sugar, and tobacco; wood and paper products; and iron and steel products.

If sound national policies are followed, manufacturing in Canada should continue to develop because the country possesses the factors which contribute to industrial success. Canada has abundant raw materials suitable for manufacturing. It is estimated that Canada has about 500,000,000 acres of forest lands, half of which are covered with merchantable timber. She stands third among the countries of the world in forest resources, Russia being first, and the United States second. Canada has about half of the forest area of the entire British Empire. These forests contain forty-five of the principal commercial woods which are suitable for manufacturing.

The coast and inland waters of Canada contain unlimited supplies of fish, including salmon, haddock, mackerel, herring, halibut, cod, and lobster, the manufacture of which into food constitutes a very large industry.

Mining in Canada has become a great manufacturing operation. The country possesses 90% of the cobalt, 85% of the nickel, 80% of

the asbestos, 4% of the gold, and 4% of the copper of the world. In 1923, the production of mines was valued at about two hundred and fifteen million dollars. It is estimated that the country, especially the Precambrian region, contains enormous undiscovered stores of valuable minerals.

The farms of Canada supply a great deal of raw materials for manufacturing industries. Dairying, for example, is responsible for manufactured products to the value of about $275,000,000 per annum; flour and grist mills for products valued at nearly $200,000,000 per annum, and the packing-house industry produces $153,000,000 worth of goods annually. The tobacco industry produces goods to the value of about $67,000,000 annually.

In addition to great stores of raw material, Canada has immense resources of fuel and power. Canada stands second in the world in coal deposits. These are not very well situated to serve manufacturing as they are chiefly in British Columbia, Alberta, and Nova Scotia, *i.e.*, at both ends of the country. There is little coal in the central section, where the bulk of manufacturing is done. In compensation, the greatest water-power resources are located in Ontario and Quebec, which together possess about two-thirds of the water-power of the country. These resources are estimated at over 18,000,000 horse power. Up to the present, Canada has developed only seven per cent. of recorded water-power resources, although the investment represented in the present development is about $620,000,000.

Good transportation is necessary for efficient manufacturing in order that raw material may be transported to the factories and the finished products away from the factories. Canada has 39,773 single track miles of steam railways and 1,725 miles of electric railways. Canadians also operate nearly 5,000 steam and sailing vessels, and the excellent system of canals facilitates inland water transport.

Industry requires educated and skilled staffs. The Canadian system of education, through its universities, colleges, and schools, provides excellent general education, largely at the public expense. During the past fifteen years a considerable number of technical schools have been established which accommodate both day and night pupils and fit them for work in industrial establishments. An increasing amount of attention is being given to research work by the Honorary Advisory Council of Scientific and Industrial Research and by the universities, technical schools, and other educational institutions.

The securing of capital is always one of the chief problems in industrial development. A country may have great natural resources, but, owing to the character of its people, or instability of government, capital will not undertake the task of developing and marketing these

raw materials. Canada has always been regarded as a good field for the investment of capital. Apart from capital supplied by Canadians, the chief sources from which capital is drawn are Great Britain and the United States. The following table shows the ownership of capital invested in the specified manufacturing industries of Canada in 1920:

SOURCE OF CAPITAL INVESTED IN CANADIAN MANUFACTURES

Nature of Industry	Total value of securities	Owned in Canada	Owned in U.S.A.	Owned in U.K.	Owned in other countries
	$	%	%	%	%
Lumber (forest production)	441,008,000	72.3	14.5	13.1	0.1
Lumber (mill production)	266,840,000	68.3	19.0	12.5	0.2
Pulp and paper	294,551,000	69.5	20.0	7.4	3.1
Central electric stations	(a)292,448,000	79.8	14.6	4.2	0.2
Steel furnaces and rolling mills	117,124,000	57.7	40.8	0.9	0.6
Copper smelting (includes some lead, zinc, and nickel)	111,922,000	13.4	51.7	34.0	0.9
Agricultural implements	86,393,000	50.0	38.8	10.0	1.2
Foundry and machine shop products	53,611,000	48.8	39.8	11.2	0.2
Electrical apparatus	52,666,000	43.4	45.1	9.6	1.9
Cotton textiles	(b)51,425,000	85.6	9.5	0.8	0.1
Rubber	(c)49,789,000	52.3	36.1	4.3	0.1
Shipbuilding	39,497,000	37.8	33.5	24.9	3.8
Liquors, malt and distilled	34,532,000	89.4	2.0	8.4	0.2
Flour and cereal mills	34,407,000	90.8	3.9	4.4	0.9
Drugs and chemicals	33,171,000	32.9	52.0	14.3	0.8
Fish canning and curing	25,936,000	58.5	29.4	12.0	0.1
Patent or proprietary medicines	25,013,000	16.8	79.4	0.9	2.9
Woollen textiles	24,905,000	98.5	0.4	1.1	0.0
Automobiles and accessories	24,498,000	30.7	69.2	0.1	0.0
Paint and varnish	23,966,000	48.3	50.1	1.6	0.0
Asbestos mining	23,308,000	63.9	29.9	6.2	0.0
Leather boots and shoes	22,122,000	99.3	0.4	0.2	0.1
Building and construction	21,934,000	85.8	10.3	3.8	0.1
Hosiery and knit goods	19,956,000	90.3	6.0	3.5	0.2
Artificial abrasives	11,621,000	0.9	98.7	0.4	0.0
Biscuits and confectionery	10,524,000	95.2	4.5	0.3	0.0
Leather tanning	9,906,000	99.1	0.9	0.0	0.0
Brass and copper	9,235,000	43.0	56.6	0.4	0.0
Total for specified industries	2,212,308,000	64.8	24.4	9.6	0.8

(a) $3,580,000 securities undistributed.
(b) Distribution of $2,062,500 bonds not known.
(c) $3,600,000 bearer bonds not recorded as to ownership.

It is gratifying to note from the above table that about two-thirds of the capital invested in these industries in Canada is Canadian, and that the leading industries are chiefly controlled by Canadian investors. This is considered to be a remarkably good record for a comparatively new country such as Canada and demonstrates that Canadians have faith in their own country and also that they have large sums of money available for investment.

A country possessing all the above mentioned natural resources and necessary factors for manufacturing should endeavour to develop

her raw materials through the various industrial processes within the boundaries of the country, and produce, for home consumption and export, finished products, instead of exporting the raw material and allowing other countries to manufacture articles from them. If this policy is continued and extended, more capital will be attracted, more work provided in Canada, and the entire population will benefit through the development of the country.[1]

[1]The statistical tables in this article were published by the Natural Resources Intelligence Service of the Department of the Interior of Canada, in December, 1923, under the title "Canada, Natural Resources and Commerce".

SCIENTIFIC RESEARCH IN CANADA

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Organised scientific research first took form in Canada with the establishment of the Geological Survey of Canada in 1841 under the direction of Sir William Logan. Before that time scientific activities were limited to individual efforts, and, while much was accomplished by these sporadic investigations in revealing the natural resources of the country, coordination and organised work was required and this was supplied by the Survey. At its inception, the work of the Survey was confined to the investigation of the geology and mineral resources of Canada, but it was not long before its scope broadened to include both zoology and botany, and more recently, a division of anthropology and ethnology has been added. It has thus become in reality a Natural History Survey whose work is distributed over a vast extent of territory, from the Arctic ocean to the Great Lakes and from the Atlantic to the Pacific.

Further governmental stimulus to research is supplied by agricultural colleges and experimental stations. The colleges, which are maintained by the provincial governments, are primarily educational institutions, but, nevertheless, they offer abundant opportunities for research in problems pertaining to agriculture, opportunities that are well made use of, especially in such institutions as the Ontario Agricultural College at Guelph, Ontario, and the Macdonald School of Agriculture at Ste. Anne de Bellevue, Quebec. The stations maintained by the Dominion government, of which the chief one is located at Ottawa, devote their energies to experimental work and investigation along such lines as soil analysis, genetics, and economic entomology.

Still further opportunities for investigation are offered by the Dominion Department of Fisheries under whose auspices there has been formed a Biological Board, to which is assigned the duty of conducting researches bearing directly or indirectly upon the fisheries of the Dominion. The Board is composed of two members representing the Department of Marine and Fisheries, two representing the fishing industry, and eight nominated by as many Canadian universities. Two laboratories are maintained by the Board, one on the Atlantic

coast at St. Andrews, New Brunswick, and one on the Pacific coast near Nanaimo, Vancouver island. The stations are well equipped with the apparatus necessary for biological and oceanographical research and with boats, and the accommodation they provide is fully utilised during the summer months by members of the staffs of the various universities and by advanced and graduate students carrying on research under the guidance of the Station Directors. The results obtained from these investigations are published by the Board partly in a series entitled "Contributions to Canadian Biology"; partly as "Studies from the Biological Stations", consisting of papers recording the results of researches carried on at the stations but originally published in some special scientific periodical; and partly as "Bulletins of the Biological Board of Canada", these consisting of papers of a more popular character, dealing with researches having a direct interest to those connected with the fishery industry.

As a fourth stimulus to scientific research offered by the Dominion government mention should be made of the work of the Honorary Advisory Council for Scientific and Industrial Research. The Council furnishes financial aid for the carrying on of approved investigations, eighteen grants for this purpose having been made during the year 1922-23. In addition it awards fellowships, studentships, and bursaries to graduate students of Canadian universities who desire to continue their studies with a view to fitting themselves for scientific investigation. The appointments are tenable in any Canadian university where opportunities are afforded for the desired studies, but, failing these opportunities, permission may be granted for study in Great Britain or in some foreign country. During the year 1922-23 the Council awarded three fellowships, twenty-two studentships, and fourteen bursaries, all of which, with the exception of one bursary, were held in Canadian universities.

In offering these awards the Council recognises the need for the development in our universities of men fitted by training and endowment for prosecuting research. Research work is being more and more actively carried on in practically all the Canadian universities, and most of them offer a greater or less number of post-graduate courses. In the majority of cases, however, these courses lead only to the Master's degree, the pressure of undergraduate work interfering materially with intensive post-graduate work, even if the equipment and library facilities, so necessary in scientific work, are available. But in two, at least, of the larger universities, Toronto and McGill, graduate work is well organised in the scientific departments and opportunities are afforded graduate students for proceeding to the Doctor's degree, the requirements for which are maintained at a high standard and include

the production of a meritorious thesis based on original investigation. The number of students availing themselves of these opportunities is steadily increasing. Canada's need for well trained investigators is becoming more and more appreciated as her material resources become better known, and grants from public funds and private generosity are both contributing to create in her universities opportunities that will, in time, supply the corps of men, well trained in the methods of scientific research, that her industrial and economic development demands.

FOUNDATIONS AND AGENCIES OF CANADIAN ZOOLOGY

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Introduction.—Activities of a zoological nature in Canada involve a number of agencies having much in common but differing widely in origin and outlook. In addition to private individuals, these agencies include various societies, departments of the Dominion and provincial government service, and educational institutions.

In describing these agencies merely with the object of pointing out their general distribution, it is unfortunate in many ways that some of the significant facts concerning the development of zoology in Canada must either be omitted or but casually mentioned. The position of Canada, for example, as the northern half of the North American continent excepting Alaska, has attracted a great deal of attention from external sources in connexion with problems of faunal distribution. Certain phases of the early history of Canada, more especially of Arctic exploration and the operations of the fur-trading companies of the interior, have a very definite bearing upon modern economic problems. The physical diversity of the country, as well as the contiguity of three oceans, has determined for it an imposing complex of economic issues in which all interests touching the utilisation and protection of animals are concerned. Of especial importance to Canadian zoologists is the gradual development of internal organisation in Canada which has taken place since Confederation in 1867—the replacement of external sources of effort and incidentally of all kinds of exploitation by co-ordinated development from within.

Zoology in the Societies.—Faunistic zoology with reference to Canada owes at least a large part of its progress to the efforts of private individuals and to the support given by them to the establishment of local societies. It is perhaps no exaggeration to state that much of the best work of older Canadian naturalists has been lost owing to lack of facilities both for publication and for the permanent preservation of specimens. Societies devoted to natural history, as distinct from game-protective and similar associations, now exist in various centres throughout the Dominion, the list including several which are representative of the respective provinces. Though the majority are recent or lack means of publication, a few have been influential because of

early establishment, continuity of function, or published records. Among the latter may be mentioned the Ottawa Field Naturalists' Club, the Entomological Society of Ontario, the Natural History Society of Montreal, the Nova Scotian Institute of Science, and the Natural History Society of New Brunswick.

Present tendencies are in the direction of further organisation of such societies, the growth of which is desirable from many points of view. There is a movement, also, towards the formation of societies along industrial or conservational lines. Among the recent organisations of this nature and contributory to zoology are the Canadian Fisheries Association (1914) and the Canadian Forestry Association (1915) both represented by current publications.

Of the scientific societies of Canada which contain a zoological component, the Royal Canadian Institute, Toronto (1851), and the Royal Society of Canada, Ottawa (1882), occupy outstanding positions as regards the advancement of science in all respects, the latter being in every sense the national scientific society of Canada.

Zoology in the Dominion Government Service.—No better view is to be had of the nature and diversity of economic zoological problems in Canada than is afforded by a survey of the technical branches of the Dominion government service. In order to understand their relations, however, it is necessary to keep in mind certain features both of Canadian practice and of federal and provincial functions.

At the time of Confederation, or shortly afterwards, newly organised federal departments took over some of the major functions of the older provinces, and later extended their sphere of action as the newer provinces were established. Various branches of technical service were established as the need of public supervision became evident, and in general a close association with the administrative service was maintained. At the same time the organisation of the provinces was in part re-constituted and re-defined. Nearly all the characteristics of Canadian practice, and many peculiarities of it, are traceable in one way or another to the British North America or Confederation Act, either as definite assignments of function or, on the other hand, lack of provision owing to unforeseen conditions.

As organised at present the departments of the Dominion service which contain a zoological component are those of Mines, Agriculture, Marine and Fisheries, and Interior. More or less interdepartmental functions are represented by the Wild Life Protection Board and the research organisation of the Privy Council as well as by occasional co-operative effort in respect of the national collections and arctic investigation.

The Geological Survey of Canada, now attached to the Department of Mines, is one of the oldest, and from the faunistic standpoint, most effective agencies contributing to Canadian zoology. Its field surveys have been distinguished by broad consideration of the natural resources, while its reports, published more or less continuously since 1843, are indispensable to zoologists, either because of incidental references to animals, or because they include important specific studies and synoptic lists. The Victoria Memorial Museum at Ottawa, housing the national collections, largely accumulated through officers of the Survey, contains important animal collections, for the most part in charge of specialists for the various groups.

Owing to the dominating importance of agriculture in Canada the federal department is not only advanced in technical organisation but includes many activities of common interest as between agriculture and economic zoology. The most outstanding feature is a system of experimental farms, inaugurated in 1886, and now embracing over thirty farms and experiment stations. The older organisation has since 1912 been replaced by some thirteen divisions several of which, on the zoological side, are of interest, either because of the work being carried on through the officers of the department, or because of the opportunities suggested for useful co-operative research.

One of the older activities of the department, the entomological service, is now organised as the Entomological Branch. It controls some twelve laboratories, and maintains the national collections of insects, the most complete in Canada.

Of the various services attributable to the Department of Marine and Fisheries, at least three are of particular interest to Canadian zoology. One of these is the development since Confederation of a magnificent system of fish-hatching establishments, the existence of which provides a notable foundation of practice for the extension of research bearing on the propagation and growth of fishes. A further service is that resulting from the establishment in 1893 of the office of Commissioner, the effect of which has been to bring some measure of scientific and zoological enquiry into matters of administrative regulation. A third service, due in no small measure to the assistance of the British Association, is the maintenance of scientific fisheries research. This movement, inaugurated in 1899 with the appointment of the Biological Board of Canada, has resulted in many additions to the literature of marine biology, and in the establishment of permanent laboratories on the Atlantic and Pacific coasts. These laboratories provide facilities for marine investigation not otherwise available in Canada.

While it would be difficult to summarise the various services of the Department of the Interior, it may be said that the functions of the department as regards animals are for the most part in the direction of conservation. Some recent activities in setting aside tracts of country in the northwest territories and in the arctic islands as animal preserves are of especial interest as showing the attention which is now being given to the accessories of administration in the arctic and sub-arctic region.

Of the various branches of the department, the Dominion Parks Branch is especially significant as regards Canadian zoology, because it exercises supervision over a system of park areas, for the most part in western Canada, which by legislative definition are game sanctuaries. Included in the system are several devoted to the protection and propagation of bison, wapiti, and antelope. The system originated with the creation of the Rocky Mountains park in 1887, and apart from its phenomenal growth and popularity, is also recognised as ensuring for all time facilities for the observation of the larger Canadian animals.

The encouragement afforded by the national parks for increase and protection of animal life has been greatly enhanced by the establishment of bird sanctuaries, and the setting aside under the Forestry Branch of a relatively enormous area of forest reserves, all of which supplements the established parks, reserves, and game sanctuaries of the respective provinces.

An important and unique piece of legislation, administered through the Parks Branch, is the Migratory Birds Convention Act, assented to originally as an international treaty, and designed for the more uniform protection of migratory birds in the various states and provinces.

The Natural Resources Intelligence Branch has important functions in respect of publicity. In 1921 this branch took over the functions of the Canadian Commission of Conservation. The latter body, established in 1910, had made many enquiries as regards the fur-bearing animals, fisheries, and animal products in general. Its reports are in many ways among the most valuable documents relating to Canadian economic zoology because they attempted, at least, to bring together whatever objective information was available. They also have a particular interest because of their relation to the development of the fur-farming industry. This industry has since grown so that it includes over a thousand farms, has developed an extensive literature, and incidentally has revealed the desirability of several lines of economic zoological research.

In relation to all scientific fields, the Dominion Research Council may be described as the only effective co-ordinating agency in Canada as regards research of an economic outlook. Established in 1915,

under the supervision of a sub-committee of the Privy Council, this body has operated either by supervising research or providing stipends for research workers. Its services on the zoological side have been largely in relation to fisheries problems, in giving prominence to the desirability of economic research in zoological laboratories, and in providing stipends for the encouragement of graduate students of the universities along such lines.

Zoology in the Provinces.—Government organisation in the various Canadian provinces shows many differences in extent and detail, but generally speaking has an underlying pattern of uniformity in keeping with the confederation principle. There is some recognition of natural history and maintenance of museum collections. Development of zoological research bearing on the game and fur-bearing animals and on the fisheries has not proceeded to any notable extent, though local interests are largely involved. Administrative control of the game animals, however, varying more or less in the different provinces, has resulted in many items of practical legislation as regards the protection of animals and provision for their scientific and industrial investigation. Natural increase has been provided for by the establishment of parks, game sanctuaries, and forest reserves. Ontario has developed a system of fish-breeding establishments which supplement those of the Dominion government, and a fisheries laboratory has been instituted in the provincial university.

The provincial governments have strong departments of agriculture. Owing to the fact that education is a provincial function there is a close association between the provincial departments and the provincial agricultural colleges, so that representation as regards entomology, animal husbandry, and other branches of zoological interest is attained through the colleges. The several provinces having provincial agricultural colleges are Nova Scotia, Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia, and in nearly all cases these are also closely associated with the provincial universities. Quebec is exceptional in that the agricultural colleges, including Macdonald College of McGill University, are non-provincial. Generally speaking, the very close relationship of government departments, agricultural colleges, and universities offers the very best opportunity for co-operative zoological research, the advantages of which have not yet been wholly realised.

Zoology in Educational Institutions.—Representation of zoology in the educational system of Canada concerns various grades of instruction from the primary schools to the professional and graduate faculties of the universities. Educational patterns in general are based on supervision by provincial departments of education. The zoological

component is partly linked with agriculture, including agricultural classes in ordinary schools, schools designated as agricultural, and the colleges above-mentioned.

Canadian institutions of higher learning are relatively independent as regards curricula, and since they represent a very remarkable diversity in principle and origin, they show also a corresponding diversity in their recognition of zoology and other branches of science. Because they are variously occupied with teaching programmes, including the various branches of professional education, the effectiveness of their laboratories as regards either theoretical or economic research depends upon their degree of development, research facilities, or personal selection. Zoological science, however, is represented in at least fourteen academic institutions of college or university rank. The list includes some universities of the maritime provinces and Quebec which have a most interesting relation to the development of eastern Canada, namely, Dalhousie University, Halifax; St. Francis Xavier, Antigonish; the University of New Brunswick, Fredericton; Laval University, Quebec; and Montreal University. The chief laboratories, however, belong to a group of institutions of the centre and west, including McGill University, Montreal, the outstanding private foundation of Canada; Queen's University, Kingston; the Western University, London; McMaster University, Toronto; and the provincial universities of Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia.

As an older institution in an advanced and populous province, strengthened by the combined influence of several federated sectarian colleges and professional schools, the University of Toronto, the provincial university of Ontario, has undergone a very marked scientific development including specialised representation in all biological branches. The western universities, at least three of which have been established within fifteen years, are noteworthy for their rapid and wholesome growth in respect of all the sciences and their application, including zoology in relation to agriculture.

Systematic zoology and zoological collections form a part of the establishments of most universities whether public or private. In the case of the provincial institutions the collections are more or less closely associated with the provincial government. The most extensive collections of this nature are in Toronto, namely in the Provincial Museum, the Biological Museum of the University of Toronto, and the Royal Ontario Museum of Zoology.

Zoological research, so far as organised in the Canadian universities, is characterised by complete freedom as regards the various fields and especially as between pure and applied branches. If there are

any directional tendencies, they are towards general organisation of graduate functions and the encouragement of investigation along economic lines. While the latter has been hindered to some extent by the notion that it is inappropriate to general education, it has also been stimulated by such agencies as the Dominion Research Council and the Biological Board of Canada; perhaps, also, by an increasing conviction in favour of research useful in one way or another to the Dominion.

THE FAUNAL AREAS OF CANADA

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Canada, with its vast extent of nearly 3,000 miles east and west and over 1,000 miles north and south, naturally contains several distinct faunal areas, and it is the object of this paper not only briefly to describe and delimit these biotic areas but to suggest reasons for their existence.

It has been recognised since the earliest days of biology that temperature and moisture are very important factors in the distribution of plant and animal life, but it remained for Merriam ('94) to put this relationship in the form of a law and to divide North America into zones and faunal areas on this basis.

Merriam's conclusions, and consequently his proposed biotic areas, have been attacked, chiefly from the botanical side, by several writers, their main contentions being (1) that other factors are more important than those he selected as criteria, (2) that his meteorological data were insufficient, (3) that his areas were based partly on meteorological data and partly on biotic data, and (4) that the ranges of most species do not coincide with his proposed areas. On the other hand his faunal regions have been adopted and widely used by the majority of zoologists, especially the mammalogists and ornithologists.

To accept the objections as valid without due enquiry, and disregard Merriam's work entirely; or to adopt his areas as definitely fixed and requiring no further investigation are both equally regrettable courses to pursue. The first course is merely negative, and it is to be remarked that those who object most strenuously to Merriam's divisions have given us nothing better in their place. The second course is objectionable because it may lead to assumptions in regard to distribution which are not in accordance with the facts.

Our investigations into the correlation between the limiting factors and the distribution of the terrestrial biota of Canada have led us to the following general conclusions:

Temperature and precipitation are the chief factors which determine distribution. When we say the chief factors, we do not mean to

imply that they are the only factors which influence distribution. The duration of light intensity throughout the growing season, the geological formations and the consequent nature of the soil, the topography, and the velocity and direction of winds all play a part, and the interaction of these factors with one another or with one of the major factors is also of significance in regard to distribution. But however important locally these other factors may be, temperature and precipitation are the factors which determine the general biotic character of the different regions.

Northward distribution, as contended by Merriam, is controlled chiefly by the accumulated temperatures of the season of growth in plants and of reproduction in animals. Merriam selects 6° C. as the temperature at which physiological activity begins in plants and reproductive activity in animals. This is obviously only an average, as some plants do not show any signs of growth until a much higher temperature has been reached, and some animals (*e.g.*, the Canada jay) have their reproductive period at a temperature far below this. However, checking phenological data against meteorological data has shown us that 6° C. is as satisfactory a basis as can be selected.

Southward distribution is governed by the mean temperature of the hottest part of the year, and the southern border of one zone, as thus determined, agrees with the northern border of the next lower zone as determined by the accumulated temperatures. We have taken the hottest month, instead of the hottest six weeks, as taken by Merriam, because of the shorter season of growth in many regions of Canada.

Distribution east and west is controlled chiefly by precipitation. We have taken this as a basis rather than humidity, because (1) the precipitation data are far more accurate than the humidity data, (2) in many parts of Canada a very considerable proportion of the moisture in the spring is derived from the melting snow, which falls at a time when the humidity is very low, but is included in the precipitation data. The distribution of precipitation throughout the year is often of as much, or more, significance than the total amount.

We have drawn the lines limiting the zones and faunal areas on our map entirely from meteorological data, with the exception of the line between the Assiniboian and the Algonquan, in which case we have failed to find a satisfactory meteorological basis, while the biotic difference between prairie and forest is most conspicuous.

The Meteorological Basis.—In Merriam's paper comparatively little space was given to the meteorological factor, and tables of his data were not published. He stated, however, that the map of the United States, based on biological data, agreed satisfactorily with a

map showing isotherms of accumulated temperature. The portions of Canada which appear on his maps were evidently based on the biota alone, for at that time very few meteorological stations were in operation in the interior of the country.

In the present paper, the work of calculating the accumulated temperatures and determining the limits of the life zones was done for the Dominion of Canada, in so far as the information was available. The critical values proposed by Merriam were found unserviceable, for reasons which will be presently shown.

The accumulated temperature for a point where daily normal mean temperatures have been determined may be obtained by adding together the mean daily temperatures during the season of growth. The sum is equal to the product of the mean temperature for the whole period involved and the number of days. It is a rough integration of the area under the annual temperature curve and above the line of basal temperature, 6° C. or 43° F.

In the first place it would seem logical to treat this base-line as zero in each case; the area below the base-line can hardly be regarded as significant, yet it weights the figures considerably, especially if the Fahrenheit scale be used. (The figures given by Merriam indicate that he used crude sums only.) Another consideration then presents itself. Since we are multiplying temperature by time, it is important to express both factors in appropriate units which will bring out their true relation to one another. We are seeking a basis of comparison between insular and continental climates, where the annual curve of temperature is very differently shaped. The centigrade scale, with its larger units of temperature, gives more weight to temperature and less to time than the Fahrenheit scale, the time being measured in days in each case. A trial of both systems showed that the centigrade was preferable; when Fahrenheit was used, points on the Pacific coast, where the growing season is long and cool, appeared too warm in comparison with points in the interior, where it is short and hot.

In practice the accumulated temperatures were computed by means of monthly normal temperatures, these only being available. The mean temperature of each month (expressed in centigrade degrees and diminished by six) was multiplied by the number of days in the month, and the products added together. A simple graphic device was employed to determine the quota of heat contributed by months when the temperature was only part of the time above the base-line.

The northern boundary of the Hudsonian zone was fixed provisionally at 350 day-degrees; that of the Canadian at 700; that of the Transition at 1480; and that of the Austral at 1880.

According to Merriam, the southern boundary of each zone is determined by the mean temperature of the hottest part of the summer. The mean temperature of July should express this factor adequately for Canada (August is warmer on the eastern and western coasts, however). In order to find the limiting values, the following method was adopted; the zones were first defined by drawing the isotherms of accumulated temperature, and then in each zone the place was sought which has the hottest July. So much heat, at least, the biota of that zone must be able to endure.

The north limit of trees, which divides the Arctic from the Hudsonian zone, was said by Supan to coincide with the isotherm of 10° C. (50° F.) for the warmest month. The figures are a good approximation; and it may be mentioned that, where the season is so short, the mean temperature of the warmest month is the main factor in the accumulated temperature. Observations at stations on the coast of Labrador suggest that Supan's figures may be a trifle too low, and that points in the Arctic zone may attain a mean temperature of 11° C. (52° F.) for the warmest month. It may be assumed, at least, that Arctic species are able to endure this amount of heat.

The hottest part of the Hudsonian zone is the lower Mackenzie valley, where the mean July temperature is 16° C. (61° F.). This is the temperature of the hottest month at Victoria, B.C., and at St. John, N.B., so that if Hudsonian species can endure so much heat, they should be able to occupy most of our eastern and western coasts; they should also find congenial conditions on the north shore of Lake Superior and on the adjacent plateau. The hottest July in the Canadian zone appears along its southern border in Ontario, where mean temperatures of 19° C. (67° F.) are attained. This is the temperature of the warmest month at San Diego, California, on the edge of the Upper Austral zone, as Victoria is on the edge of the Transition. We see, therefore, that, while the zones may be well defined in a continental area, in a region of insular climate, such as the Pacific coast, each zone completely overlaps its next southerly neighbour.

The question of moisture is in a less satisfactory state than that of temperature. Attempts to correlate the well-defined moisture zones of desert, steppe, prairie, forest, and rain-forest with the meteorological factors, and express the result in a simple formula, have met with indifferent success. Precipitation indeed has been measured with fair accuracy, but evaporation, a factor of nearly equal importance, has not. Moreover, the seasonal distribution of precipitation and the amount occurring as snow, etc., are factors of which it is difficult to take account. In the present state of our knowledge a brief description of the various faunal areas and the amounts of precipitation they receive is all that can be attempted.

The Arctic and Hudsonian zones, between Hudson bay and the Yukon territory, are a region of low precipitation, not more than ten to fifteen inches annually. It seems that a large proportion occurs in summer, and this fact, coupled with the low evaporation, insures the plant life against injury by drought. In Labrador the precipitation is heavier, increasing to 40 inches at Belle Isle. The bulk of it still occurs in summer, and the increased amount seems to be beneficial, for the forest about the head of Lake Melville reaches merchantable size. In the alpine region of the cordillera the conditions are different; the precipitation generally exceeds 40 inches, and a large proportion (70 per cent. at Glacier) is in the form of snow. An excess of snow is even more discouraging to plant life than a deficiency of water. Where more snow falls than can be removed by melting and evaporation, permanent snowfields and glaciers are formed, and life is locally extinguished. Where the snow lies for the greater part of the year, mountain meadows are formed; tree growth is excluded, apparently by the shortness of the season and the permanent wetness of the soil. Trees are restricted to the better-drained sites about the edges of the meadows.

The Sitkan faunal area of the Canadian zone has a very heavy precipitation, from 40 to 200 inches annually. While the winter is the wettest season, the summer is by no means dry, seldom receiving less than ten inches in the three months. The region is covered with a luxuriant rain-forest, consisting chiefly of conifers. Many of the species reappear in the interior wet belt of the Cariboo, Gold, and Selkirk ranges; but some are absent, and the region may be regarded as a separate faunal area, termed the Kootenayan. Its annual precipitation varies from 35 to 65 inches; and the spring and summer are relatively dry, with about six inches each.

The Nechakan faunal area covers most of the interior plateau of British Columbia. Its annual precipitation is from 10 to 35 inches, rather evenly distributed through the year. It is covered by a sparse forest growth, the chief species being the lodgepole pine.

East of the mountains the precipitation of the Canadian zone falls off to less than 12 inches in parts of Alberta and Saskatchewan; then rises slowly eastward to 40 inches in Nova Scotia. In the east, the southern part of the zone is generally wetter than the northern (measuring moisture by precipitation), while in the west the northern and southern parts have about the same precipitation, but the former is wetter by reason of the low evaporation.

The greater part of the prairies of Canada belong, as their accumulated temperatures show, to the Canadian zone. Hitherto they have been assumed to belong to the Transition, and the whole of the prairie

region north of the Upper Austral zone has been designated the Campestrian faunal area. This name should be reserved for that portion of the prairie region which is actually Transition; the part within the Canadian zone may be named the Assiniboian faunal area, and the Canadian forest east of the mountains may be termed the Algonquan faunal area.

The Assiniboian faunal area is separated from the typical Canadian forest to the north by a zone of scrub, consisting largely of poplars and willows. The whole of the Canadian zone in Saskatchewan receives from 12 to 18 inches of precipitation, while portions of Alberta and Manitoba receive 20 inches or more. In all three provinces the boundaries between grassland, scrub, and forest tend to follow the isotherms rather than the isohyets. The prairie recurs, however, in the Peace River valley, where the temperature is certainly low, while little is known about the precipitation. It seems fairly certain that while climatic factors have much to do with the location of the prairies, edaphic factors are of nearly equal importance.

The Transition zone is discontinuous in Canada, appearing at intervals along the southern border. Its westermost portion is the Vancouveran faunal area, covering the lower portion of the east coast of Vancouver island, the adjacent mainland coast and intervening islands, and the lower Fraser valley. It is warmer and in general drier than the adjacent Sitkan faunal area, the annual precipitation ranging from 30 to 80 inches. The summer is particularly dry, with only two inches of rain at Victoria, and not much over six inches anywhere. The wetter portions are densely wooded with a forest which is continuous and virtually identical with that of the Sitkan faunal area; the drier parts have a more open and scrubby forest covering, consisting of southern species which here reach their northern limit.

The Okanagan faunal area covers portions of the Thompson, Fraser, Okanagan, Similkameen, and lower Columbia valleys. It is a region of light precipitation, generally less than 20 inches annually, somewhat evenly distributed through the year. It is covered in part by a park-like forest of yellow pine, (which also extends into the Canadian zone for some distance), and in part by grassland in which sagebrush and cactus make their appearance. The valley floors are generally occupied by the latter type and the slopes and benches by the former. Seepage is probably as important as precipitation in defining their relative positions.

The Campestrian faunal area appears in southern Alberta, and probably extends along the 49th parallel in Saskatchewan. It is a region of light precipitation, from 12 to 15 inches annually, with nearly half the total in the three months of summer. It consists of grassland

resembling that of the Okanagan faunal area, from which perhaps it should not be distinguished.

The Alleghanian faunal area appears in southern Ontario and Quebec, and (doubtfully) in central Nova Scotia. The annual precipitation is from 25 to 40 inches; in the United States, the isohyet of 20 inches roughly marks the boundary between this and the Campestrian faunal area. The precipitation is well distributed throughout the year; there is no pronounced dry season. The country was originally covered by a forest in which deciduous trees predominated.

The Upper Austral zone appears in Canada in two widely separated areas; the Sonoran faunal area is represented in the lower valleys of the Okanagan and the Thompson; and the Carolinian faunal area in Ontario, in the Niagara peninsula and the counties bordering Lake Erie. The former is arid, with 9 to 15 inches of annual precipitation. The vegetation resembles that of the Okanagan grassland, but is sometimes so scanty as to approach desert conditions. The latter has about 30 inches precipitation annually, well distributed; it was formerly covered by hardwood forest, differing from the Alleghanian by the absence of many northern species and the presence of southern forms not elsewhere found in Canada.

The Biological Basis.—In discussing faunal areas, one of the main facts which must be borne in mind is that the boundaries of these areas are not really sharp lines, but that contiguous areas blend almost imperceptibly one into the other. This is only to be expected from the fact that there is no sharp break in the climatic factors. Furthermore the tolerance of each species probably differs a little from that of every other species. Thus as we pass from one area to another with a quite distinct fauna we traverse a region in which the species of the former area gradually drop off and the species of the latter area become more and more conspicuous. The same thing is true of the individuals of a given species, the number of individuals becoming less and less as we pass from one region to another. Thus while it is necessary to draw the boundaries of faunal areas on a map as sharp lines it must be remembered when looking at such a map that these lines really represent the centre of a blending border-belt between the areas.

In considering the distribution of the biota of Canada we find that there are many species of very wide range which occur in several faunal areas. In many cases (*e.g.*, the song sparrow, horned lark, red squirrel, deer mouse) these wide-ranging species exhibit variations in size and colour in different parts of their range, so that different subspecies are characteristic of the various areas. Other wide-ranging species (*e.g.*, the moose, red-breasted nuthatch, pine siskin, tree swallow)

are remarkably constant in character throughout the whole of their range. There are, on the other hand, many species which are restricted to a single faunal area, or which have the bulk of their population within a certain faunal region and which thin out rapidly as soon as the boundary of that region is passed. It is these species (which we may term characteristic species) taken collectively that give the faunal character to the regions they inhabit.

Within a given faunal region there are usually certain limited areas whose biota is not that of the surrounding region. Thus peat-bogs and mountain-tops are "islands" of a northern zone in a more southerly one. When the biota of North America advanced on the retreat of the last ice-sheet the more northern forms of life were able to persist in these cool "islands" and now exist in those localities, often hundreds of miles from their relatives which passed on to the north. In the case of rivers which flow southward we find that their valleys provide an avenue for the northward extension of southern biota.

Over the greater part of Canada the faunal areas cover, uninterruptedly, considerable territory, but in the mountainous regions of the west they are so broken that it is impossible to represent them, even as far as we know them, except on a map of very large scale. Each mountain-side is an area in which there are belts of the Canadian, Hudsonian, and, if snow-capped, Alpine regions.

The difficulty of dealing with the faunal areas of Canada is greatly increased by the fact that data on the distribution of the animal life of the Dominion is as yet very incomplete. There is not a single locality the whole fauna of which is known. We have fairly accurate data on the distribution of birds and mammals—hence the preponderance of these in the following lists of characteristic species—but a vast amount of work remains to be done before our knowledge of the distribution of the other groups of animals is at all adequate.

It is a pleasure to acknowledge the aid received in the matter of distributional data from the following zoologists—Dr. E. M. Walker, Odonata and Orthoptera; Mr. P. A. Taverner, birds; Dr. J. H. McDunnough, Lepidoptera, Diptera, and Hymenoptera; and Dr. J. H. Emerton, spiders.

The zones and faunal areas, as we recognise them, are as follows:

ARCTIC ZONE
HUDSONIAN ZONE
ALPINE REGION
CANADIAN ZONE
- Algonquan Faunal Area
- Assiniboian Faunal Area
- Kootenayan Faunal Area

Nachakan Faunal Area
Sitkan Faunal Area
TRANSITION ZONE
Alleghanian Faunal Area
Campestrian Faunal Area
Okanagan Faunal Area
Vancouveran Faunal Area
AUSTRAL ZONE
Carolinian Faunal Area
Sonoran Faunal Area

Arctic Zone.—The characteristic terrestrial mammals of this zone are the polar bear, musk ox, barren-ground caribou, arctic fox, and arctic hare. The distinctive birds are the snowy owl, gyrfalcon, willow ptarmigan, snowflake, and lapland longspur. It is the nesting ground of many of our waders. Characteristic insects are the butterflies *Eurymus nastes* and *Brenthis polaris*, the flies *Tipula arctica*, *Pogonomyia quadrisetosa*, and *Stenosyrphus mallochi*, and the hymenopterans *Bremus arcticus* and *Ichneutes reunitor.*

Hudsonian Zone.—The characteristic species of this zone are the wolverine, deer mouse (*Peromyscus maniculatus*), great gray owl, rough-legged hawk, northern shrike, pine grosbeak, white-winged crossbill, white-crowned sparrow, fox sparrow, tree sparrow, and red-poll, the dragonfly *Aeschna caerulea*, the locust *Melanoplus borealis*, the lepidopterans *Brenthis chariclea*, *Oeneis jutta*, and *Anarta cordigera*, and the hymenopterans *Bremus frigidus* and *Enizemum tibiale.*

Alpine Region.—The territory which we have designated the Alpine region is an area which cannot be placed in any zone or faunal area, because, being mountainous, it consists of an intricate mosaic of Canadian, Hudsonian, and Arctic-Alpine zones. Some species which occur in this region, but which naturally do not extend over the whole of it, are the Rocky Mountain goat, mountain sheep, pica, hoary marmot, white-tailed ptarmigan, Franklin grouse, gray-crowned leucosticte, and evening grosbeak.

Algonquan Faunal Area.—The characteristic mammals of this area are the lynx, Canada porcupine, star-nosed mole, and northern jumping mouse. Distinctive birds are the white-throated sparrow, slate-coloured junco, American crossbill, arctic three-toed woodpecker, Canada jay, Blackburnian warbler, magnolia warbler, myrtle warbler, Tennessee warbler, bay-breasted warbler, hermit thrush, and olive-backed thrush. *Pardosa glacialis* and *Theridion zelotypum* are characteristic spiders. Among insects the following may be regarded as distinctive: the dragonflies *Sympetrum danae* and *Somatochlora minor*, the locusts *Circotettix verruculatus* and *Mecostethus gracilis*, the butter-

flies *Eurymus interior*, *Melitaea harrisi*, and *Basilarchia arthemis*, the flies *Cyrtopogon predator*, *Stenosyrphus genualis*, and *Cynorhina confusa*, the bumblebee *Bremus borealis*, and the ant *Lasius niger neoniger*.

Assiniboian Faunal Area.—This area, which, together with the Campestrian, constitutes the prairie region of Canada, has many characteristic species, among them being the prong-horn, coyote (*Canis latrans*), prairie red fox (*Vulpes regalis*), kit-fox, prairie hare, badger, northern pocket gopher, striped gopher, Richardson's ground-squirrel, little vole (*Microtus minor*), long-tailed weasel, prairie chicken, Leconte's sparrow, clay-coloured sparrow, and the damselfly *Coenagrion angulatum*. It is to be noted that these species occur also in the Campestrian, which is, however, marked biotically by the intrusion of southern forms not found in the Assiniboian.

Kootenayan Faunal Area.—This area is well-marked meteorologically and botanically, but the fauna of the region has not been worked out with sufficient precision to enable us to say what species are characteristic of this region. A race of the red squirrel (*Sciurus hudsonius ventorum*) appears to be restricted to this area.

Nechakan Faunal Area.—Faunistic data from this region are so scanty that it is impossible to characterise it zoologically. As far as our present information goes it appears to be a region of overlap of Algonquan, Alpine, and Sitkan forms, which are able to exist here because of the differences in elevation in this area. It is an area of intergradation of races of the deer mouse.

Sitkan Faunal Area.—Species characteristic of this area are the varied thrush, Audubon's warbler, sooty song sparrow, the vole *Evotomys caurinus*, and a race (*vancouverensis*) of the red squirrel.

Alleghanian Faunal Area.—This area, being part of the Transition zone, naturally has no species which are entirely restricted to it, but its northern boundary coincides with the northern limit of many southern species. Such species are the wood thrush, bluebird, catbird, towhee, Baltimore oriole, bobolink, the wild cat and cotton-tail, the spider *Aranea ocellata*, the dragonflies *Aeschna constricta* and *A. verticalis*, the damsel-fly *Enallagma carunculatum*, and the locusts *Melanoplus luridus*, *Orphulella speciosa*, and *Acrydium hancocki*.

Campestrian Faunal Area.—The chief species, the occurrence of which marks this area off biotically from the Assiniboian, are the sage grouse, lark sparrow, lark bunting, McCown's longspur, Brewer's sparrow, and the rock wren.

Okanagan Faunal Area.—Species characteristic of this area are the Columbian sharp-tailed grouse, sage thrasher, white-throated swift, canon wren, pigmy nuthatch, burrowing owl, and Columbian ground-squirrel, the grasshoppers *Anabrus longipes* and *Circotettix undulatus*, and the dragonfly *Macromia magnifica*.

Vancouveran Faunal Area.—Characteristic species of this region are the Oregon towhee, rusty song sparrow, Macgillivray's warbler, golden pileolated warbler, Douglas squirrel, western raccoon, and a race of the varying hare (*Lepus americanus Washingtoni*), the grasshoppers *Neduba carinata* and *Tropidischia xanthosoma,* and the dragonflies *Aeschna californica* and *Sympetrum illotum.*

Carolinian Faunal Area.—Distinctive species of this area are the cardinal, Carolina wren, blue-gray gnatcatcher, yellow-breasted chat, caerulean warbler, blue-tailed skink, hog-nosed snake, the grasshoppers *Amblycorypha oblongifolia, Orchelimum volantum,* and *Conocephalus attenuatus*, and the dragonfly *Libellula semifasciata.*

Sonoran Faunal Area.—There is a region, roughly triangular in shape, which extends from Spence's Bridge east to Kamloops and south to Nicola, which seems, both by its accumulated temperature and biota, to belong to the Upper Sonoran faunal area. The lazuli bunting, dusky horned lark, and poor-will are three species which occur here. This area is not shown on the map, because the scale is too small. It lies at the western border of the Okanagan in the southern part of British Columbia.[1]

[1]For bibliography see appendix.

FIG. 18. LIFE ZONES OF CANADA

The numbers on the boundaries of zones indicate the sums of the daily temperatures above 6°C. for the year. This map illustrates "The Faunal Areas of Canada" and "The Vegetation of Canada".

THE VEGETATION OF CANADA

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A broadly comprehensive regard of the vegetation of Canada contemplates it in its relation to that of North America as a whole. Roughly speaking, the continent is a great triangle with its apex in southern Mexico, the source of many elements of our vegetation (*e.g.*, Cacteae, Mimoseae, Eriogoneae). The base of the triangle may be taken to extend from the easternmost extremity of Newfoundland to northwestern Alaska.

As we approach the middle of this triangular area from any point along its east or west sides, we pass from forested regions toward the desert—once the Great American Desert—much of which now blossoms as the rose. It was the merit of the late Professor John Macoun to recognise the possibilities for agriculture of the Canadian portion of this area, which begins, in the east, in the vicinity of Winnipeg (Macoun 1922). The base of the triangle follows, save for a great indenture toward the south caused by Hudson bay, the line of northern tree limits, passing along the coast of Labrador to the mouth of the Mackenzie river and the northern coast of Alaska. Disregarding the Rocky Mountain region for the moment, the desert regions form a second triangle with its apex coincident with that of the first, its western side defined by the eastern limits of the Pacific coastal range of mountains, and its eastern side by a line running north almost directly to Winnipeg, and following, if stated in detail, the western limits of the grassland deciduous forest transition (Livingston and Shreve, 1921).

In northwestern Canada, that great tongue of elevated land, embracing the Gold and Selkirk ranges of Canada and the Rocky mountains there and to the south, merges vegetationally with the Coast Range mountains and permits the southern extension of types found common to this and the Coast range southward toward Mexico, but excluded from the desert spaces between. This topography at the same time permits the commingling of forms from the south not common to the two mountain systems and in part accounts for the wonderful vegetation of the British Columbia region, nourished by moisture from the Pacific ocean conserved in the snows and cool airs

of high altitudes. The space between the Coast range and the Rockies is characterised by meagre precipitation, and may be regarded as the northern extension of the Sonoran desert in Canada.[1] The great grassy prairies to the east of the Rockies are the corresponding extensions of those great plains or steppes, the home of the American bison, treeless save for "poplar bluffs", clothed with crisp, nourishing grasses and adorned with numberless flowers in their season. This great area is one with the Chihuahuan desert of Mexico, and ends only in the northern reaches of Manitoba, Alberta, and Saskatchewan by giving way to open forest of Banksian pine, and this, still farther north, to rock and tundra. The great area east of the grassland is less easily described. Broadly, it is the deciduous forest area which, extending from Winnipeg to the Atlantic seaboard, gradually becomes transformed in Canada to the evergreen forests, the noblest tree of all being the white pine. Beyond their northern limits are the smaller or hardier types of trees, which array their ranks across the continent from Ungava bay to Hudson bay, and from Churchill to the mouth of the Mackenzie, facing the wide north.

Out of this north during the Glacial Period came the great ice-sheet, which pushed before it the vegetation which had previously existed, and brought with it the hardier arctic forms. This ice covered the whole of the continent as far as ca. 36° N. lat. in the east and 46° N. lat. in the west. During its recedence, plants were left in isolated areas, so that now we find identical arctic and boreal forms in widely separated localities, to be regarded as vegetational islands, usually in muskegs or areas at high elevations.

We may now consider the vegetational areas of Canada in greater detail, those more remote and inaccessible receiving less attention than those through which the visitor to Canada may pass, and which, accordingly, may fairly claim more specific interest.

Arctic Zone.—This zone is approximately the Northwest Territories with Quebec north of the 51st parallel, and is all that region north of the tree limits, white and black spruce (*Picea canadensis* and *P. mariana*) being the outermost sentinels. Indeed, the white spruce advances beyond the accepted, necessarily somewhat arbitrary line, as drawn upon the map, and is found in depressed localities where it gains protection from the sweeping winds with their drying effect. Within the Barren Lands, willows of "man height" (*Salix Richardsonii*) to the minute species (*S. rotundifolia*), birches (*Betula nana*, *B. glandulosa*), depressed heaths, e.g., *Cassiope tetragona*, "most commonly used for fuel by those travelling in the Barren Lands",[2] or erect but low ones

[1]Kamloops, ca. 10 inches; Vancouver, ca. 60 inches.
[2]J. B. Tyrrell, 1897.

(*Kalmia polifolia*), constitute the tree and shrubby vegetation of a "treeless, rocky wilderness." The tundra, with its rich summer covering of flower-gems, supports also some 230 or more flowering species of which 37 per cent. are common to Canada and Spitzbergen, and 26 per cent. are circumpolar (Holm, 1922). A smaller number are common to Asia and Canada. Fifty or more fungi have been reported (Dearness, 1923), and 175 species of algae, both fresh and brackish water types (Lowe, 1923), from the extreme north.

The surface of this "treeless, rocky wilderness" is varied by lakes and rivers, great and small, by sandy ridges of glacial origin (kames, eskers), and by bogs in which the water is always frozen a few inches below the surface. Tyrrell describes "moss glaciers"—literally sliding bogs—the whole history of which is recorded in the broken icy front. Here, however, the tender grasses, ground birch, and willow afford abundant food for the reindeer in summer. In the autumn the herds turn to the more hospitable woodlands to the south where they find tree buds, moss, and lichen to their needs.

The vascular plants of the extreme north (coast of the Arctic ocean) collected on the Canadian Arctic Expedition, 1913-18(Macoun and Holm, 1921) include at least 230 species, of which the genus *Saxifraga* is represented by 15 species, *Carex*, *Salix*, and *Ranunculus* each by 12, *Pedicularis* by 7, and *Draba* by 5. On the other hand, the *Compositae* are 23, and the grasses 22 in number. *Picea canadensis* is the only coniferous tree reported from this expedition. It is interesting to note that one of these vascular plants, *Lupinus nootkatensis* is established and vigorously spreading in the Orkney islands.[3]

Hudsonian Zone.—(Subarctic forest zone: Macoun and Malte, 1915). This zone indicates at once by its position the general climatic conditions which determine the southeast-northwest obliquity of distribution of Canadian plants, the most northerly extensions of the zone being fully ten degrees farther north on the western side of the continent. The warm, moisture-laden winds of the Pacific constitute the dominant determining factor, though one must not suppose that climatic influences alone can be made to explain the distributions of individual species. Thus white cedar (*Thuja occidentalis*) enters the Hudsonian at the west of James bay, while Banksian pine (*Pinus banksiana*)—more characteristically Hudsonian—is excluded from this area because of the presence of a calcareous soil (Fernald, 1919).

The rolling surface, interrupted by thousands of lakes and ponds, placid streams, and roaring torrents, contains great areas of sphagnum bogs (muskegs), which may be traversed only when frozen. The

[3]Communicated by Professor G. W. Scarth

vegetation of these relicts of the receding glaciers, consisting of many plants which range far south of the Hudsonian zone, is very uniform everywhere.

The trees of the Hudsonian, roughly in order of their farthest north distribution, are: *Picea mariana* (black spruce), *P. canadensis* (white spruce), *Larix laricina* (tamarack), the three being approximately coincident, *Betula papyrifera* (canoe birch, from the bark of which the Indians have for generations constructed their canoes), *Pinus banksiana* (Banksian pine), *Abies balsamea* (balsam fir), *Populus balsamifera* (balsam poplar), *Populus tremuloides* (aspen), and *Prunus pennsylvanica* (bird cherry). The balsam fir ranges well northward with the spruces to the east of Hudson bay, but to the west is the southernmost of the above list. The spruces at their northern outposts may attain great age (upward of 500 years) and in places even within the Arctic Circle a height of 40 to 50 feet (Dr. John Richardson, 1848-9), but in less favourable situations they are "twisted and gnarled" and of low stature.

A cross-sectional view of the Hudsonian zone from Lake Athabasca to Doobaunt lake is afforded by J. B. Tyrrell (1897); also by J. W. Tyrrell (1908), whose collections included 233 species, of which the lichens numbered 23, liverworts 1, true mosses 13, lycopods 4, ferns 5, with but one horsetail. The rest are seed-plants of which some range north into the arctic, while others are of a southern complexion: *Abies balsamea*, *Acer spicatum*, found by Tyrrell as far north as Fort Chipewyan on Lake Athabasca, *Cornus canadensis*, *Linnaea borealis*, *Arctostaphylos Uva-ursi*, etc. Throughout the Hudsonian there is an abundance of berry-producing shrubs and woody plants of lower stature among which the heaths are very prominent.

The vast areas included in the Arctic and Hudsonian zones have been but little known up till the present except through the records of various expeditions which have been limited to the slower and more laborious means of travel. With the use of the Royal Air Force for exploration our knowledge will expand more quickly. An example of the possibilities of this source of information is afforded by the recently published Report of the James Bay Forest Survey (1923).

Canadian Zone.—In the Hudsonian we meet with longitudinal differentiation increasingly as we proceed southward. As soon as the lower limits of that zone are left, the effect of the continental climate, and of the coastal climates, becomes more and more evident in the vegetation. The Canadian zone (map, p. 206)[4] contains, therefore, the extensions of the north and south regions to which the reader's attention was first drawn. It will thus be more convenient to describe the Canadian zone as the longitudinal changes occur, namely, from

[4]The Canadian zone is chiefly the Algonquan faunal area of the map which was made particularly to illustrate the preceding paper.—*Editor.*

one coast to the other. We proceed from east to west. The visitor to Canada will travel in this direction wholly in the Canadian, save only between Quebec and the Great Lakes, and in the west, passing through the western cordilleras, where altitudes will reveal vegetation analogous to that of the Hudsonian and Arctic; or in the more remote regions which he may find opportunity to penetrate.[5]

The Canadian zone is more homogeneous longitudinally in its northern belt, which bears the same general aspect across the entire continent, and in this respect resembles the Hudsonian, with which it merges along its northern limits. These, east of James bay, extend from the southern end of this bay to the south of Lake Mistassini then along the 51st parallel almost to Cape Whittle, the coast of Quebec and northwards from there being Hudsonian. West from James bay the line follows the northern limit of the balsam fir to the Great Slave lake, beyond which it turns sharply northwest and so to the mouth of the Mackenzie. In the east, the Canadian zone embraces the major portion of Newfoundland, the maritime provinces, and a broad strip of southern Quebec from the southern end of James bay to Cape Whittle, with Anticosti island.

The trees of the northern belt, though predominantly coniferous, have perhaps always constituted a broken, mixed forest, and are the same as those of the Hudsonian zone, with the addition of *Thuja occidentalis* (white cedar), *Fraxinus nigra* (black ash), and *Alnus* (alder). A very large proportion of the area is occupied by innumerable lakes and rocky exposures, and by muskeg in which tamarack and white cedar are constant elements.

The southern belt of the Canadian zone is deciduous forest, or, as it is known to the lumbermen, the northern hardwood forest, in which, also, the original stand was probably an admixture of coniferous and deciduous trees, in the ratio of one to two.

This immense vegetational region reaches its western limit in Manitoba, where the distribution of the species is much disturbed under the influence of the topography of this extensive lake country. Here is to be found a commingling of deciduous and coniferous forests, the latter playing an increasingly dominant rôle toward the north and east (the mesophytic coniferous).

The forests vary from pure hardwood stands dominated by *Fagus grandifolia* (beech), *Acer saccharum* (sugar maple), or by *Betula lutea* (yellow birch), with which certain coniferae are admixed. Of these *Picea rubra* (red spruce) was probably dominant originally, and to-

[5]Visitors who may be able to include the eastern seaboard in their itinerary may be referred, for guidance, to the papers of Ganong, Nichols, St. John, and Victorin, cited in the list of references.

gether with *Pinus strobus* (white pine) and *Tsuga canadensis* (hemlock), constituted the original great timber resources of eastern Canada. Probably 60 per cent. of the area in question in Ontario was occupied by forests of this character.

Special Features of Eastern Canada.—Sable Island—This small sandy island 20 miles long by one mile wide, has a romantic history and is of special interest botanically (H. St. John, 1921). Entirely composed of sand dunes, the differences in habitat result only from slight differences of level, and consequently of soil water, and different salinities in this. Phytogeographically, the island presents the interesting picture of being the meeting place of boreal and southeastern types, and containing a few (7 per cent.) endemic forms, which, having characters not pronounced enough to entitle them to specific rank, are yet sufficiently differentiated to render them separable as varieties. Of the boreal types, *Empetrum*, and of the southern, *Calopogon pulchellus* and *Myrica carolinensis* (from Texas northward) may be cited. A similar array of plants may be seen on sandy beaches and dunes along the coast of the maritime provinces (see Nichols).

Nova Scotia and New Brunswick—The topographical features include rugged uplands of granite rocks, some limestone areas, vales, bogs and swamps (drained and undrained), beaches and dunes, and the extremely interesting salt marshes at the head of the Bay of Fundy.

The raised type of peat bog occurs in a fine degree of development in both New Brunswick and Nova Scotia. In its mature condition it bears a vegetation of shrubs—*Myrica gale*, *Andromeda polifolia*, *Chamaedaphne*, *Kalmia* and *Vaccinium*. In suitable (drier) situations *Schizaea pusilla* (the rare curly-grass), *Sarracenia purpurea* (pitcher plant), and *Drosera* (sun-dew) occur; also *Bartonia iodandra*, *Habenaria clavellata*, *Utricularia cornuta*, etc. (Ganong, Nichols). The great numerical development of ericaceous shrubs in America, as a climatic phenomenon, may be noted.

The salt marshes of the Bay of Fundy have originated by the deposition of silt carried up by tidal waters; when reclaimed they are "wonderfully fertile". The vegetation in its highest development, that is at the highest levels, includes *Limonium carolinianum* (sea lavender), *Plantago maritima*, *Puccinella maritima* (goose grass), *Spartina juncea*, *Triglochin maritima*, *Glaux maritima*, etc. (Ganong, 1903).

Recent exploration by Dr. Fernald (1921) has revealed the presence in Nova Scotia of a great many coastal-plain elements which have found their way from the south through Nova Scotia to Newfoundland.[6]

[6] A small area of southwestern New Brunswick and a strip across Nova Scotia (Halifax—Avon River—Annapolis—Lunenburg) are Transition.

FIG. 19. WHITE PINE (*Pinus strobus*)
Courtesy of Blakeslee and Jarvis

St. Lawrence Valley—The lowlands of the St. Lawrence in the Province of Quebec present a vegetation (Transition zone) distinctly more southern than that of the Appalachian hills (Canadian zone) to the immediate south.[7] But reaching the city of Quebec—which is a critical point—there is a complete change to the Canadian again, and not farther than the Island of Orleans we meet the sub-arctic and halophytic stragglers *Primula mistassinica*, *Plantago decipiens*, etc. From this point eastward, the shores are distinctly bleaker, and when we reach the Saguenay we have a thorough mixture of Hudsonian and Canadian types.

Most interesting to the botanist is the Gaspé peninsula which has revealed an immense wealth of endemic species or of Cordilleran species not elsewhere found in eastern America. At least two summits in this district, the serpentine mass at Mt. Albert and the vast granitic expanse of La Table, appear to have escaped glaciation and exhibit an ancient flora partly endemic, partly Scandinavian, and partly Cordilleran. On the alpine prairies of Mt. Albert (about 4,000 feet) one finds together *Lychnis alpina*, *Rhododendron lapponicum*, *Adiantum aleuticum* (Alaskan), and *Polystichum scopulinum* (Cordilleran).

The flora of the Laurentides north of the St. Lawrence, owing to glaciation and acid substratum, is essentially uniform. But behind their granitic masses lies Lake St. John, where on the sands, recent exploration (Victorin, 1921) has revealed a relict halophytic flora. This case is paralleled by that of the "Ouananiche", a salmon now completely adapted to the fresh water of this lake.

Transition Zone.—The valley of the St. Lawrence westward from Quebec to the Great Lakes and that of the Ottawa as far as Sudbury (north of the Georgian bay) is the northern extension of the great eastern deciduous forest region. At once the number and variety of deciduous trees is increased. Of these the following indicate closely the limits of the Transition as laid down in the map: *Carya cordiformis* (bitternut), *Carpinus caroliniana* (hornbeam, ironwood), *Quercus alba* (white oak), *Ulmus fulva* (slippery elm), *Ulmus racemosa* (cork elm). A longer list (page 215) includes the more widely known trees, which, however, have a distribution extending through New Brunswick and Nova Scotia, sometimes including, also, the Gaspé region, e.g., *Tsuga canadensis*. Some of these, also, are found beyond the western limits, in southern Manitoba and Saskatchewan, *e.g.*, white cedar. Of these trees, one above all will attract attention, the beautiful *Ulmus americana* (American elm), which will be seen in all its grace and stature in the open fields along the railway west of Montreal. The best known, however, is the sugar maple, *érable à sucre* of the "habitant", from

[7]This note contributed by Professor M. Victorin.

which maple syrup and sugar are obtained by evaporation of the sap drawn from the trees in very early spring—the "sugaring season"—a time of annual country festival and work. *Acer rubrum* (red maple), seen generally in moister woods, is the tree which furnishes the high colour notes of autumn, and the leaf of which is the national emblem. In the far west where autumn colouring is meagre, *Acer circinatum* (vine maple) is brilliantly hued.

The following trees, typical of the Transition may be seen in the vicinity of Montreal: *Ostrya virginiana* (ironwood), *Acer saccharum*,

FIG. 20. AMERICAN ELM (*Ulmus americana*)

A. saccharinum, *A. rubrum*, *A. nigrum*, *Ulmus americana*, *U. fulva*, *U. racemosa*, *Fagus americana*, *Fraxinus pennsylvanica*, *Celtis occidentalis*, *Populus deltoides*, *Salix* spp. *Pinus strobus*, *Thuja occidentalis*, *Abies balsamea*, *Picea canadensis*, and *P. nigra*. In the open areas of the Transition is the home of *Crataegus*, a large number of species of which are found in the vicinity of Montreal. In low-lying pastures they may be recognised by their curious forms, caused by the constant pruning of cattle.

"Muskegs" (peat bogs, savanes) are of frequent occurrence. A long chain of peat bogs, formed in a depression of the Appalachian hills, is traversed by the Canadian National Railway between Quebec and Montreal. Here the tamarack, white cedar, and black spruce are constant denizens. Indeed, locally, these are the "white cedar swamps" which, when drained, afford rich land (containing calcium) for cultivation.

Such bogs, readily accessible from Montreal, occur at St. Thérése and, still nearer, at St. Hubert.[8] Here may be found: *Kalmia angustifolia*, *Rhodora canadensis*, *Chamaedaphne calyculata*, *Aster nemoralis*, *Solidago humilis*, *Gentiana Andrewsii*, *Bartonia virginica*, *Oxycoccus macrocarpus*, *Rubus* spp., *Salix balsamifera*. *Sarracenia purpurea* (the pitcher plant) does not occur at St. Hubert, but does at St. Thérése. Other common bog plants are *Ledum groenlandicum*, *Kalmia polifolia*, *Andromeda polifolia*, *Myrica gale*, *Menyanthes trifoliata*, *Drosera*, *Eriophorum*, and *Carex* spp.

Extensive bogs which have been profoundly altered by the causes following deforestation may be seen at Lake Memphremagog (Lloyd and Scarth, 1922). Here the bog forest, decrepit from the erosion of the forest floor, is now invaded by *Typha*, *Alisma*, *Sagittaria*, *Carex*, *Eleocharis*, etc., that is, the normal course of change from hydrosere to xerosere has been reversed.

Shrubby forms of the Transition include: *Dirca palustris* (moosewood), *Viburnum alnifolium*, *V. acerifoliuum*, *V. cassinoides* (arrowwoods), *Rubus odorata* (purple-flowered raspberry), *Amelanchier spicata*, *Rhus toxicodendron* (poison ivy).[9] Herbaceous spring plants include: *Trillium grandiflorum*, *T. erectum*, *T. undulatum*, *Uvularia perfoliata* (bellwort), *Erythronium americanum* (dog's-tooth violet), *Orchis spectabilis* (showy orchis), *Arisaema triphyllum* (Jack-in-the pulpit), *Claytonia caroliniana* (spring beauty), *Viola* spp. (violets, blue, white, and yellow-flowered), *Hepatica triloba*, *H. acutiloba*, *Dicentra cucullaria* (Dutchman's breeches), *Dicentra canadensis* (squirrel corn), *Sanguinaria canadensis* (bloodroot), *Dentaria diphylla* (pepper-root), *Waldsteinia fragarioides* (barren strawberry), *Polygala paucifolia* (flowering wintergreen), *Phlox divaricata* (blue-phlox), *Carex* spp. (sedges), *Asarum canadense* (wild ginger), *Caulophyllum thalictroides* (blue cohosh), *Tiarella cordifolia* (false mitrewort), *Mitella diphylla*

[8]Bogs, on the south side of the St. Lawrence, are accessible from Sorel, Que., and from Huntington near Montreal. An extensive area of peat occurs between Montreal and Ottawa, west of Vankleek Hill, on the Canadian Pacific Railway, and also in the Niagara peninsula south of St. Catharines.

[9]*Visitors are warned of its virulence for many persons.* Trailing or climbing by roots, with *pinnately 3-foliolate leaves.* Often confused with *Psedera quinquefolia* (Virginia creeper), with 5-foliolate leaves and tendrils. Some persons are immune, but to determine this may prove costly.

(mitrewort), *Trientalis americana* (star flower), *Cypripedium hirsutum* (showy lady's slipper). Herbaceous summer plants include: *Habenaria psychodes, Gentiana crinita, Asclepias incarnata, Physostegia virginiana, Chelone glabra, Lobelia cardinalis, Pogonia ophioglossoides, Calopogon pulchellus, Arethusa bulbosa, Sarracenia purpurea, Aster novae-angliae, A. cordifolius, A. paniculatus, Solidago canadensis, S. nemoralis, S. juncea* (goldenrod). The asters and goldenrods give the dominant colour notes to the herbaceous vegetation. In moist rich woods *Monotropa uniflora* (Indian pipe, or corpse plant) is well worth seeing. This is a mycorrhizal plant (Lloyd & MacDougal, 1900). *Lespedeza, Oenothera*, and *Asclepias* are well represented genera.

Austral Zone.—Approaching Toronto from Montreal, the cultivation of the grape vine advises us that a warmer region, culminating in the Austral zone, is being entered. This is represented in a strict sense by a narrow strip of country parallel to the northern shores of Lake Erie, 30 to 40 miles in width in the "Niagara Peninsula". Some of the southern elements of this zone, however, range farther northward, and accordingly, a line from Toronto to the southern end of Georgian bay may be regarded as a limit of a tension zone between the Transition and the Austral. An excursion south from Hamilton would bring the visitor into full contact with the vegetation which has here a pronounced southern aspect (southern hardwood forest).

Woody plants include: *Morus rubra* (red mulberry), *Magnolia acuminata* (cucumber tree), *Liriodendron tulipifera* (tulip tree, "poplar" of the southern mountains), *Asimnia triloba* (paw-paw), *Gymnocladus dioica* (Kentucky coffee tree), *Cercis canadensis* (red-bud or Judas tree)—Pelee island, *Nyssa sylvatica* (sour gum), *Castanea dentata* (chestnut), *Sassafras variifolium, Platanus occidentalis, Quercus* (ten species), *Carya ovata* (shagbark hickory), *C. alba* (mockernut), *C. glabra, Fraxinus quadrangulata* (blue ash), *Cornus florida*, picturesque in spring with its large white bracts and in autumn with its deep red foliage.

Among the herbaceous plants are: *Opuntia Rafinesquii* (prickly pear), *Nelumbo lutea* (yellow lotus), *Hibiscus Moscheutos* (swamp rose-mallow), *Ipomoea pandurata, Apios tuberosa, Asclepias phytolaccoides, Liatris spicata, Podophyllum peltatum, Lupinus perennis* (wild lupine), *Desmodium* (tick trefoil), *Euphorbia corollata* (flowering spurge), *Phlox pilosa, Hydrophyllum appendiculatum, Monarda didyma, Gerardia pedicularia, G. virginica, Campanula americana, Lobelia syphilitica, Vernonia altissima, V. illinoensis, Silphium terebinthinaceum, S. perfoliatum, Helianthus decapetalus, H. divaricatus, Coreopsis tripteris, Cacalia tuberosa, Cypripedium hirsutum, Hydrastis canadensis* (golden seal), and *Panax quinquefolium* (ginseng), the last two at one time abundant but now practically extinct.

Transition continued.—Returning to the Transition (north of Toronto), we may note that this zone extends in a narrow tongue along the Ottawa river, and ends at Sudbury. A narrow strip, about 20 miles wide, also fringes the eastern and northern shores of Georgian bay, to be continued as a small area west of Lake Superior, south of the Canadian National Railway from Port Arthur to Fort Francis.

About the shores of Lake Superior the vegetation is of more northern ("subarctic": Agassiz) aspect, but Professor John Macoun determined that only a narrow strip of a "few hundred yards" was of this character, due to the low temperature of the lake waters (Macoun, Autobiog., 1922).

The country north of the Great Lakes beyond Sudbury as far as a point about 50 miles west of the Lake-of-the-Woods is essentially similar vegetationally to the Canadian hardwood zone, and is included in the latter. But the Lake-of-the-Woods itself, which, together with the neighbouring lakes, Winnipeg, Winnipegosis, Manitoba, and Rainy, is a relict of the glacial Lake Agassiz, has a vegetation which displays both northern and southern affinities, the former indicated by 50 per cent. of the species, the latter by 22 per cent., the remainder being continental (MacMillan, 1897).

The Plains—Some thirty miles east of Winnipeg begin the prairies and the Canadian Great Plains. This area covers the south-western portion of Manitoba, a line running from Winnipeg to Edmonton indicating, in general, the northern boundary of this formation, and the foothills of the Rocky mountains being the western limit (at Calgary, C.P.R.; at Entrance, C.N.R.). This, the "Great Lone Land", once supposed useless, is now a vast wheat-growing area of ever-increasing economic importance, as is indicated by the number and distribution of the railways.

The uniformity of the vegetation, so far as its general character is concerned, will soon impress itself upon the observer. There is, however, a change from east to west correlated with the lessening rainfall and higher elevation as the cordilleras are approached, producing a more pronounced semi-arid condition. The region is divisible into three prairie steppes, limited by lines running northwest from the international boundary at long. ca. 98° and 103° 50′.

The eastern steppe has been called the "weedy prairies" (John Macoun, 1922), because of the tallness of the conspicuously flowered plants (Pentstemons, asters, goldenrods, sun-flowers, and many other Compositae), and is bounded westward by an elevation, the Pembina escarpment, clothed with forests of oaks, poplars, etc., encountered just west of Portage la Prairie. Here the trees of the eastern deciduous area find their diminishing foothold along the streams, and this con-

stitutes a characteristic aspect of the vegetation. The western migration of trees along these paths has in the past been checked by prairie fires. A similar aspect of vegetation is seen to the south, in the Dakotas, Nebraska, and Kansas. *Ulmus americana* (white or American elm), *Quercus macrocarpa* (burr oak), *Populus tremuloides*, *P. balsamifera*, and especially *Acer negundo* (ash-leaved maple) are here found.

The vegetation picture presented as one proceeds west from Winnipeg may be well shown by repeating the map-notes of Professor Hind, who previous to 1859 made an exploratory examination of the region (Hind, 1859):

"Elm, ash, oak, and poplar skirt the river (Salé) on both sides"; "undulating prairie dotted with clumps of, or marshy, and covered with, low willows"; "rolling prairie, clumps of balsam, spruce, young aspens"; the Assiniboine River west of Brandon, "slope covered with poplar, in the valley (about four miles wide) oak, ash, elm, maple"; above Portage la Prairie, "aspen, oak, birch, elm, poplar, numerous in order named"; Pipestone creek, "narrow skirting of oaks, elms, and willows"; open, level prairies, "grassy, or marshy, no woody plants or clumps of willows"; east of Qu'appelle, "groves of poplar"; then "arid, treeless prairie", and finally, "great buffalo plains".

A belt of about 150 miles in width running north and south parallel to the Manitoba lakes is more densely forested.[10] There the more eastern and northern affinities of the vegetation are indicated by the Banksian pine (to lat. 52°), mountain maple, and white elm, while the southern incursion is indexed by the ash-leaved maple. This belt is crossed by the Canadian Pacific Railway between Winnipeg and Whitewood, and by the Canadian National between Winnipeg and Melville.

The Banksian pine is the dominant open-forest tree marking the transition of the grass-land to the Hudsonian zone. This belt in Alberta is entered a short distance north of Edmonton.

The second steppe, extending as far as 103°.30′ long., to a glacial moraine—the Coteau de Missouri—west of Estevan, is more distinctly arid. In sandy tracts *Mamillaria vivipara* appears; it is to be found, also, farther westward with *Opuntia polyacantha*, as the most northern outliers of the Mexican-American cactus flora. Trees are becoming smaller, or, save the poplar, scrubby oak, and ash-leaved maple among the stream beds, are disappearing altogether. "Poplar bluffs", as these groves along streams are called, are a feature of semi-arid plains wherever soil water is more abundant. Shrubs make low thickety growths of stunted plants. *Shepherdia argentea* (buffalo

[10]Riding and Duck mountains support heavy forests of white spruce, birch, aspen, and poplar (Hind, 1859).

berry) and *Elaeagnus argentea* (silverberry) are the more distinctly xerophilous of these.

The third steppe begins at the gradient near Parkbeg on the Canadian Pacific Railway. Here the short wiry xerophilous grasses, *Bouteloua oligostachya* (grama grass) and *Buchloe dactyloides* (buffalo grass), growing in clumpy fashion, characterise the buffalo ranges. *Artemisia frigida* (sage brush) occurs in the more rocky places. Among other characteristic plants are: *Psoralea tenuiflora, Astragalus,*[11] *Oxytropis Lamberti* (loco-weed), *Eriogonum flavum* (a distinctly sclerophytic type), *Munroa squarrosa.*

One may still see buffalo trails (meandering north and south) and "wallows" in this region, registering the habits of these relicts of the primitive fauna. The great Northwest Trail lay in this belt in the United States.

In Saskatchewan (between Avonlea and Torquay) there is a peculiar region, known as the "*burn-out*" *district.* The soil is a fine impervious clay, partly and irregularly overlain with shallow sandy loam, about four inches thick, forming a hummocky surface. The depressed areas hold the rain water, and are undrained. The unevenness of surface is probably due to wind erosion. The following lists are useful, not only as indicating the striking differences of these two surfaces vegetationally, but as, in general, indicating the prairie flora (Stansfield, 1920; Derick, 1920).

Plants from the higher sandy areas: *Cladonia pyxidata, Polytrichum piliferum, Bouteloua gracilis, Potentilla bipinnatifida, Artemisia frigida, Artemisia gnaphaloides, Ratibida columnifera, Selaginella rupestris, Muhlenbergia gracillima, Pulsatilla ludoviciana, Cheirinia inconspicua, Solanum triflorum, Achillea lanulosa, Artemisia cana, Aster commutatus, Chrysopsis hispida, Erigeron glabellus, Gutierrezia Sarothrae, Solidago glaberrima.*

The plants from the clayey, depressed areas comprise, in addition to the first seven of the above list, the following: *Opuntia polyacantha, Astragalus,* and *Antennaria campestris.*

The poorly-developed drainage in the region west of the Coteau of the Missouri has given rise to numerous "salinas" (saline ponds and lakes, *e.g.*, Old Wives lake), which have a halophytic vegetation. These are passed on the Canadian Pacific Railway between Moose Jaw and Medicine Hat. Characteristic plants of this formation are: *Distichlis spicata, Hordeum jubatum, Puccinellia airoides, Corispermum hyssopifolium, Atriplex* and *Chenopodium* species, *Salicornia prostrata, Suaeda depressa, Salsola kali, Rumex mexicanus, Ranunculus cymbalaria, Plantago eriopoda, Heliotropium curassavicum, Pleurogyne fontana,*

[11]This genus contains the "loco-weed" of the southern plains region.

Crepis runcinata, Ruppia maritima. In general, this flora compares with that of the similar edaphic regions in Nebraska.

The foothills of Alberta are clothed with a more abundant covering of taller grasses and other pasture plants, such as *Festuca ovina, Festuca scabrella, Danthonia intermedia,* and many other grasses, *Carex* spp. (e.g., *C. aristata*), *Astragalus, Vicia,* and other *Leguminosae.*

Mountain Nexus—Two routes of travel may be followed; the northern from Edmonton to Prince Rupert (Canadian National Railway) through the Jasper park down the upper reaches of the Fraser, to the junction of the Nechako, up which the railway ascends to the height of land of the Coast range, and so down the Skeena to the Pacific; the southern route from Calgary (Canadian Pacific Railway) crosses the Rocky mountians, Selkirks, Gold range, down the Fraser river to the coast.

The rapid transitions in topography and vegetation on leaving the plains and entering the Rocky mountains, leading from open grasslands to subalpine forests, and finally to alpine meadows within a short time, and the great variety of plants, increasingly different as the coast is approached, afford an experience of exceptional delight to the botanist. Owing to the great altitudes and very uneven precipitation, quite aside from edaphic considerations, there are corresponding contrasts in the plant covering.

Between the great plains and the coast there lie four climatic belts. These are determined by the topography and its effect on the westerly moisture-laden winds of the Pacific. The Coastal belt (Sitkan) has the heavy rainfalls and the mild temperature which produce a forest and undergrowth so dense as often times to make an impenetrable jungle. Beyond the divide, the belt of country (Interior belt, Nechacan) lying between this and the slopes of the Rocky mountains is relatively dry, and includes distinctly semi-arid areas (transition) in the southern part of the province—the extreme extensions of the Sonoran desert. It is not heavily timbered anywhere, a light rainfall and greater extremes of temperature making for wider spacing of the vegetation. The eastern portion of the interior plateau, near the Rocky mountains, receives a heavier rainfall, has milder and less extreme temperature, and a uniformly heavier forest growth. This is recognised as the Interior, Wet Belt (Kootenayan). The Rocky mountains constitute a fourth belt with another maximum of rainfall, which, however, is uneven in its distribution. Because of the rugged and uneven character of the mountains and their great altitudes, the vegetation is extremely varied in its emplacement.

Rocky Mountains—The vegetation along both routes in the Rocky mountains is muc hthe same. The trees on the northern route are:

Larix laricina, *Picea Engelmanni*, *Pinus Murrayana* (black or lodgepole pine), *Pinus albicaulis* (white-bark pine), *Pseudotsuga mucronata* (Douglas spruce, or fir), a monotypic genus with remarkable morphological characters, and most important economically, more especially in the coastal belt. It is perhaps the largest tree of the Pacific slope, with the exception of the Sequoias of California. It attains a stature of 250 feet with a diameter of 6 to 9 feet. Being intolerant of shade, its boles are branchless and beautifully straight. The reddish-brown, hanging (spruce-like) cones are readily distinguished by the three-pointed bracts which project beyond the scales. The lumbermen recognise "red fir" and "yellow fir," distinguishable by the colour of the wood, due perhaps to conditions of growth. It has an exceedingly

FIG. 21. ALPINE BALSAM FIR OF WESTERN CANADA (*Abies lasiocarpa*)

hard, strong, springy wood with beautiful grain, especially when quarter-sawn. In British Columbia it reaches its maximum development in the south Coastal belt on Vancouver island. A feature of special interest is the unique behaviour of this tree when cut, namely, that the top of the cut stump may, in the course of years, be entirely healed over with wound tissue, in the absence of foliage. The writer recalls having observed in Oregon, in 1893, a stump of a tree upwards of 200 years old two feet high, completely healed over. The only explanation is that root grafting occurs spontaneously (Pemberton, C.C.).

Here also will be met *Tsuga heterophylla* (western hemlock), *Thuja plicata* (western red cedar), and at higher altitudes, *Abies lasiocarpa* (alpine fir), *Pinus flexilis*, *Picea Engelmanni*, *Alnus* spp. (alders), *Betula occidentalis* (birch), and *Populus trichocarpa* (black cottonwood) are abundant along the Fraser and Nechako rivers.

The Mount Robson region has been more carefully studied by Cooper, from whom the following is derived:—Talus: *Betula papyrifera*, *Salix* spp., *Picea Engelmanni*, *Pseudotsuga mucronata;* pioneer undergrowth: *Arctostaphylos Uva-ursi*, *Dryas octopetala*, *D. Drummondii*, *Shepherdia canadensis*, *Pyrola uliginosa* and *secunda;* climax forest: *Picea Engelmanni*, *Abies lasiocarpa*, *Pseudotsuga mucronata*, *Thuja plicata*, *Pinus Murrayana*, *Betula papyrifera;* shrubs: *Ledum groenlandicum*, *Menziesia ferruginea*, *Fatsia horrida*, *Viburnum pauciflorum*, and *Juniperus sibirica*; low plants: *Linnaea borealis*, *Pyrola chlorantha*, *Phegopteris dryopteris*, *Cladonia*, *Hypnum cristacastrensis;* shingle flats (left by the Robson glacier): *Epilobium latifolium*, *Saxifraga aizoides*, *Carex pauciflorus*, *Eriophorum*, *Equisetum variegatum*, *Triglochin palustris* and *Juncus* spp. followed, on increase of drainage, by almost pure *Dryas octopetala*, which may then be invaded by Engelmann's spruce, which, with association of the climax types indicated above, constitute the climax growth here also.

Interior Belt—The drainage basin of the Nechako and Fraser (that is, an area of a radius of ca. 50 to 100 miles from the junction of these rivers) is a region where the eastern and northern elements, white and black spruce and the southern Douglas spruce meet and transgress mutually their distributional areas. We may note the absence here of certain other important southern forms which are to be met with on the southern route, of which *Pinus ponderosa* (western yellow pine), *Abies grandis* (lowland fir), and *Acer macrophyllum* are worthy of mention, since the visitor may himself observe the contrast in plant distribution during his sojourn. The western limit of the black spruce is passed on the western slopes, crossing the Bulkley river west of Moricetown.

Coastal Belt: Canadian Sitkan—The forests of the western slopes of the Coast range on the north route (just west of Hazelton) will appear scarcely different from those farther south and differ, in point of fact, only in the absence from the valley of the Skeena of a few forms (*e.g.*, Douglas spruce, lowland fir, western white pine, etc.). *Abies amabilis*, *Pinus monticola*, *Tsuga heterophylla*, *Thuja plicata*, and as the sea-coast is approached, *Chamaecyparis nootkatensis* (yellow cedar), and above all, *Picea sitchensis* (tideland or Sitka spruce), a tree of magnificent proportions, meet the eye. *Taxus brevifolia*, a small yew tree with wood which makes a splendid bow, is here also. Where

there occurs a thick undergrowth of salal, *Gaultheria Shallon*, with a root parasite *Boschniakia strobilacea*, the forest is impenetrable. *Fatsia horrida* (Japanese), a much bethorned aralioid, stands awaiting the tenderfoot, reminding one of the spiny rattans of tropical forests. *Vaccinium parvifolium* (red-fruited huckleberry) is an unusual form growing here. Heavy growths of mosses and lichens, *Usnea barbata*, *Ramalina reticulata*, festoon the branches. *Collemas*, etc., grow on tree trunks, and many others in the mossy sod. Large mosses cover fallen tree trunks with thick blankets of green, and many grow luxuriantly from tree trunks and branches, as well as from the ground.

Along the shores occur a number of plants whose ranges extend northward from California (*Abronia latifolia*, *A. umbellata*, *Angelica Hendersoni*, *Gaertneria chamissonis*, *Myrica californica*, *Pentacaena ramosissima*) and overlap the southern extensions of Alaskan species (*Viola Langsdorfii*, *Nephrophyllidium crista-galli*, *Caltha asarifolia*), *Carex macrocephala*, and the Japanese *Glehnia littoralis*. Here in exposed situations, *Pinus contorta* (held by some to be identical with *Pinus Murrayana*) grows in the fashion suggested by its name.[12]

A numerous congeries of fungi is to be found. In more open spaces, as along streams occur: *Rubus spectabilis* (salmon berry) with orange berries, *Berberis aquifolium* (western barberry), *Rhamnus Purshiana* (cascara), *Vaccinium ovalifolium* (blue huckleberry), *Sambucus callicarpa* (elderberry), *Fatsia horrida* (devil's walking-stick or club). The herbaceous undergrowth includes: *Equisetum telmateja*, *Adiantum pedatum*, *Lomaria spicant*, *Asplenium cyclosorum*, *Polystichum munitum*, *Aspidium dilatatum*, *Polypodium Scouleri* (on tree trunks), *Pteris aquilina* (very large), *Lysichiton camtschatcense* (Japanese), *Erythronium grandiflorum*, *Trillium grandiflorum*, *Disporum Menziesii*, *Trautvetteria grandis*, *Tiarella trifoliata*, *Viola glabella*, *Circaea alpina*, *Aruncus acuminatus* (goat's beard), *Newberrya congesta*, *Monotropa hypopytis*.

In the Coastal belt in the Fraser region a number of more southerly types may be found. Of these the lowland fir, a tall, dark fir growing especially along streams and in lowlands, and *Acer macrophyllum* (broadleaf maple) form a characteristic skyline along streams in alluvial lands. *Pinus monticola* (western white pine) is an important element of the mountain forests. On the east coast of Vancouver

[12]One interested in forests will find a wealth of material for observation, of which a single instance. The writer recalls a remarkable case of a fallen trunk of *Thuja plicata* (in western Washington) overgrown by straddlers, *i.e.*, trees which had germinated in the moss of the prostrate trunk and which had grown to maturity, their roots passing around the trunk into the soil below. One of the straddlers has been cut, and its age determined at ca. 200 years. From this it is seen that the heart wood of the prostrate cedar, which was perfectly sound, had remained so for at least this long period of time. The sapwood was decayed.

island, *Quercus Garryana* (Garry oak) though well-developed and strongly grown, here finds its most northerly distribution, while the distinctly dry-forest southern tree, *Arbutus Menziesii* (madrona), well worth seeing, occurs here and on the opposite mainland along a narrow strip of country, on open bluffs where it may receive light. The stems are very smooth, red or pale green, according to the condition of excortication.

The mistletoes,[13] *Razoumofskya occidentalis* (on *Pinus*) and *R. tsugensis* (on *Tsuga heterophylla*) are to be found in the coastal belts.

Near the coast may be found, also, the epiphytic red alga, *Chroolepus aureus*, forming orange velvety coatings on tree trunks and branches.

Interior Dry Belt, Fraser River—Here one may see open "park lands" of *Pinus ponderosa* (western yellow pine, also called "bull pine", especially farther south). It is a splendid tree with broad plates of thick reddish to yellowish bark. At higher altitude on southerly slopes, above the winter snow-line, *Evernia vulpina* (a big yellow lichen) grows on its trunks and contributes a note of bright colour. The open grassy undergrowth, green canopies, and the reds and yellows of the boles, when lighted by a brilliant sun, afford a rare picture in colour. The open dry valleys are truly desert-like in character, a clumpy sparse vegetation of *Artemisia* (with such forms as *Eriogonum*, *Chrysothamnus*)[14] appearing, as it does in this formation farther south.

Hot Springs—The algal vegetation of hot springs may be seen at Harrison Hot Springs, Harrison lake, near Agassiz, B.C., 60 miles east of Vancouver; Potash Spring (temp. 137 F.) contains *Nostoc calidarium*; Sulphur Spring (Temp. 145 F.) contains *Dichothrix gypsophila*, *Phormidium laminosum*, and probably others.

The Selkirks—The Selkirk mountains, being rather a plateau with emergent peaks, afford a remarkable development of alpine meadows. The adjoining tree zone, which generally extends upwards along ridges, contains Coniferae with compact pyramidal alpine shape. *Abies lasiocarpa* is especially of this manner (Fig. 21).

The general forest includes: *Thuja plicata*, here attaining collosal proportions (10 feet diameter), also western hemlock, and mountain or alpine hemlock (*Tsuga Mertensiana*) with more bristling foliage, *Picea Engelmanni*, *Pinus albicaulis*, *Larix Lyallii* (Alpine larch), and *Juniperus scopulorum* (Rocky Mountain juniper).

The herbaceous growth of the meadows is of arctic appearance and the richness of colour, profusion of form, and intermingling of spring and summer types makes an irresistible appeal. Most curious are the elephant heads (*Pedicularis groenlandica*). Many species of

[13]May be seen at Port Renfrew.
[14]Rubber doubtless occurs in this and other plants, but in small quantity.

the genera, *Gentiana*, *Draba*, *Potentilla*, *Astragalus*, *Oxytropis*, *Phacelia*, *Myosotis*, *Primula*, *Castilleja*, *Solidago*, *Erigeron*, *Antennaria*, *Saxifraga*, *Androsace*, etc., occur in a numerous array.[15] At lower altitudes bog vegetation is frequently developed.

On reaching the Rocky mountains again (Canadian Pacific Railway) no further very striking differences in the vegetation are observed, but the steeper and more rugged character of the mountains alters the relative areas of the formations. The alpine meadows are more restricted, talus vegetation is more developed (*e.g.* Mount Robson above referred to), and in general, the continuity of the forest is less marked; conversely, there is less land suitable for forest growth of commerical value. It may be confidently hoped, however, that humanity will not be the loser, since here, *par excellence*, is a playground of the world—a region of wondrous beauty, where one may find touch with unmarred nature long after the more economically useful lands have been subdued to the need of man.

Marine Vegetation of British Columbia.—It would be unfortunate not to call attention to the rich marine vegetation of the waters bathing the Pacific shores of Canada, for here are found many algæ in a very rich development and of great stature. The following notes are taken from "The Marine Flora of the Pacific Coast" by Professor W. A. Setchell, (1915): The spermaphyte, or phaenogamous element of the marine flora is limited to a very few species: *Phyllospadix Scouleri* and *P. Torreyi* on exposed coasts, and *Zostera* in quiet waters. *Zannichellia* is found in brackish waters, together with *Ruppia* and one or two species of *Potamogeton*.

The Chlorophyceæ or grass-green algæ of the western coast of North America present few conspicuous species of special interest. The Ulvas and Enteromorphas are abundant. *Spongomorpha arctica*, *S. saxatilis*, and *S. spinescens* occur, while *S. coalita* is common along the whole coast and is easily recognised by its dark green rope-like masses; also *Codium mucronatum* and *C. adhaerans*, recognised by their firm structure; the former being repeatedly dichotomous, the latter forming a shapeless expansion. The curious little *Halicystis ovalis*, with its green pear-shaped fronds, one-half to one centimetre high, occurs on encrusting corallines on rocks of Vancouver island, and near Monterey, California.

The chief glory of the west-coast marine flora, and of the Phaeophyceæ as well, are the kelps or *Laminariaceæ*. No coast in the world has such a variety or can show so many conspicuous forms. The kelp flora is largely different for the different temperate regions of the

[15]A ready help will be found in "WILD FLOWERS OF THE NORTH AMERICAN MOUNTAINS" by Julia W. Henshaw.

coast; but one species, *Macrocystis pyrifera*, the long bladder kelp, extends its entire length, or at least from Sitka, Alaska, to Magdalena bay, in Lower California. This kelp is very long, 100 feet or more, with a number of stems arising from a massive root-like holdfast, branching at the base, but simple through the greater portion of their length and bearing small leaves with bases enlarged into spherical or pear-shaped bladders. Along with the *Macrocystis* occurs *Nereocystis luetkeana*, the bull kelp. It possesses a branching conical holdfast about the size of a man's fist, from which arises a stout single stem, solid to above the middle where it broadens and becomes hollow for some distance. At the top, the hollow portion, or apophysis, constricts and then expands into a large hollow bulb, beyond which is a considerable bunch of long narrow leaves springing almost immediately from its top.

Besides these three long and conspicuous kelps of deeper water are many others, smaller, but no less interesting and curious. In southern California are *Laminaria Farlowii*, *Egregia laevigata* ("sea-boa"), and *Eisenia arborea;* also *Pterygophora californica* which extends up to Vancouver island. In central California are *Laminaria Farlowii*, *L. Sinclairii*, *L. ephemera*, *Costaria Turneri*, *Dictyoneurum californicum*, *Postelsia palmaeformis*, *Lessoniopsia littoralis*, *Pterygophora californica* and *Alaria marginata*, while in the Puget Sound region and northward are found most of these, as well as *Laminaria saccharina*, *L. bullata*, *L. platymeris*, *L. complanata*, *Cymathœre triplicata*, *Agarum fimbriatum*, *A. cribrosum*, *Pleurophycus gardneri*, *Hedophyllum sessile*, *H. subsessile*, *Thalassiophyllum clathrus*, the large *Alaria fistulosa*, and other species of *Alaria*.

The rockweeds and gulfweeds of the west coast are also of great interest. Along the whole coast are to be found species of *Fucus*, *Hesperophycus*, *Pelvetia*, and *Pelvetiopsis*. In Puget sound and on the coast of southeastern Alaska *Cystophyllum geminatum* is abundant. The *Rhodophyceœ*, or red algæ, are, on the whole, much coarser and more conspicuous than those of the eastern coast or those of Europe. Some of these are beautifully iridescent under water, especially the species and varieties of *Iridœa*. Coarse *Gigartinae*, delicately membranous, but branched *Nitophylla*, the "red moss" or *Plocamium coccineum*, favourite of collectors, the large coarsely veined *Erythrophyllum delesseriodes*, the smaller, more delicately veined *Delesseria quercifolia*, and many other membranous species may be mentioned. The west coast shares with the most northeasterly part of Asia the exclusive possession of sea roses, *Constantinea*, the most complex of all the red algæ. Parasitic red algæ are relatively abundant.

The Corallines, or calcareous red algæ, are abundant on the west coast in a variety of species and associations.[16]

In conclusion, the remark may be allowed that no consistently scientific effort has been made in presenting the above sketchy picture of Canadian vegetation, nor was this intended. The brief space available would preclude more than a too general treatment of this kind for the purpose intended. It has rather been our intent to direct the attention of the visitor to those features of the vegetation which are most likely to come under observation, and to the general relations of this vegetation to that of which it is, after all, only a part, even if a large one, namely, that of North America as a whole.

The observer who is bent on a more exhaustive study would do well to provide himself with a few items of the literature available, of which a limited list is given in the appendix. Those marked with an asterisk will be found of most general informational value.

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[16]*Nereocystis luetkeana* is less luxuriant in the Strait of Georgia, and *Macrocystis pyrifera* absent from it, owing in part to the higher temperature of the Strait surface waters, as compared with that of the open sea (Cameron and Mounce, 1922), and in part to the greater alkalinity caused by the admixture of Fraser River water.

Port Renfrew, accessible from Vancouver, B.C., affords a splendid opportunity to see a rich algæ flora, including the interesting palm-like *Postelsia*, *Alaria*, and other surf plants, as well as a tide-pool vegetation of rich abundance, including *Phyllospadix* (S. Kinner, 1903).

PLANT PATHOLOGY IN CANADA

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The earliest record, so far as has been ascertained, of official cognizance in Canada of the economic aspect of insect pests and plant diseases is contained in a notice issued by P. M. Vankoughnet, Minister of Agriculture, of the Bureau of Agriculture and Statistics, Toronto, on August 15, 1856, offering three prizes of forty, twenty-five, and fifteen pounds sterling for the three best essays on the "Origin, nature, and habits,—and the history of progress, from time to time,—and the cause of the progress of the weevil, Hessian fly, midge, and such other insects as have made ravages on the wheat crops in Canada; and on such diseases as the wheat crops have been subjected to, and on the best means of evading or guarding against them." "It is hoped," continues the notice, "the warning, and the information, and the advice which may be obtained through the essays sought for, will aid in arresting the scourges of the wheat."

The first prize was awarded to H. Y. Hind, Esq., Professor of Chemistry at Trinity College, Toronto, twenty-two in all competing. His essay was prefaced by a notable quotation from a speech by Napoleon III—"The progress of agriculture ought to be one of the objects of your constant care; for upon its improvement or decline depends the prosperity or decline of empires." The essay was published in 1857 under the title "On the insects and diseases injurious to wheat crops." In the short section devoted to diseases it is interesting to note that Professor Hind discussed rusts, smuts, and ergot of wheat, and that he was fully abreast of his times in affirming that they were caused by fungi—a fact not then recognised in any text-books.

The first entrance of the Canadian government into the business of studying and giving advice on the control of diseases affecting agricultural crops dates back to 1886, and was in connexion with the establishment of the Dominion Experimental Farms. Dr. James Fletcher was placed in charge of this work as both botanist and entomologist, and he continued to act in that dual capacity up to the time of his death in 1908. A separate Division of Botany, with plant

pathology as one of the most important of its many activities, was created in 1909, for the organisation of and to the directorship of which the present Dominion Botanist was appointed. The Division of Botany now maintains a central laboratory and experimental station at Ottawa, and a series of field laboratories in charge of experts stretching across the continent.

The task of developing a Dominion-wide plant pathological service has not been simple. Canada is a large country, with agricultural and forestal interests scattered from the Atlantic to the Pacific, a distance of about 3,000 miles, and from latitude 42° far to the north. Within this vast area altitudes range from sea level to alpine heights, and the climate and other factors affecting plant life generally are extremely diverse. Reflecting these conditions the crops vary from region to region, including grapes and peaches in the milder parts, and the hardiest grains and vegetables in the colder. It is interesting to record that wheat and many other cereals mature as far north as latitude 61°, fully 600 miles north of Edmonton, Alberta, and certain vegetables much farther north still.

As bearing on the importance of supporting an efficient pathological service, it is in place to recall that Canada, with but about one-half of one per cent. of the world's population, produces 11% of the world's wheat, 11% of its barley, 18% of its oats, 15% of its potatoes, 20% of its timber, and 32% of its pulpwood.

The policy shaping the organisation of the federal service, in the attempt to meet the demands of diverse regions and special crops, has been to establish the closest connexion possible with the cultivators by studying their problems in their own localities. Thus a chain of plant pathological laboratories has been established from east to west and from north to south. Two other purposes are accomplished by this plan, the maintenance of a continuous plant-disease survey, and the making available to producers, in close proximity to them, a laboratory and experts capable of advising them on methods of disease control.

The entire phyto-pathological work of the federal government is under the direction of the Dominion Botanist, whose office and central laboratory are situated at Ottawa on the grounds of the Central Experimental Farm. In addition to administration and supervision various other activities related to plant pathology are carried out here. Research is in continuous progress on problems of general importance in pathology and plant physiology, and on special problems for which field laboratories are not equipped or provided. Plant disease inspection and certification, which is carried out under the Destructive Insect and Pest Act, also centres in Ottawa so far as the

section having to do with plant diseases is concerned. Still another service is that of inspection and certification of potatoes, the object of which is the production in Canada of pure-bred, high-yielding, disease-free seed potatoes according to the best standards known. Thus in 1923 fully 10,000 acres in all parts of the Dominion were covered twice by inspection. The amount of disease present in the fields accepted for certification at the close of the season, but still subject to tuber inspection, was negligible; so that Canada is able now to compete on equal terms or better in the world's potato markets.

The most easterly field laboratory is located at Charlottetown, Prince Edward Island. This province is eminently successful in potato growing, hence particular attention is paid to the investigation and control of potato diseases. It is not too much to state that except for the application of disease control measures commercial potato growing in many parts of the maritime provinces, where rainfall is heavy and cool temperatures prevail, would be impossible.

Laboratories for the study of the diseases of mixed crops are established at Fredericton, New Brunswick and Ste. Anne de la Pocatière in the Province of Quebec.

Investigational work on fruit crop diseases is carried on in widely separated points, namely, Kentville, Nova Scotia; St. Catharines, Ontario; and Summerland, British Columbia. In Nova Scotia, justly noted for its orchards, the control of apple-scab is most important. St. Catharines is situated in the Niagara district, a garden spot of Ontario and one of the finest fruit districts in America. Here peach-yellows has been practically eliminated—for which credit should be given to the entomologists and plant pathologists of Ontario. Much effective work has also been done on the mosaic and the leaf-curl of raspberries, a part of which has resulted, through the operation of a certification and inspection service, in placing at the disposal of growers nursery stock practically free from these maladies, and except for which the cultivation of this important crop would have been abandoned. British Columbia is likewise the home of a large and growing fruit industry, covering extensive areas characterised by very different climatic conditions and a variety of important diseases.

Another group of laboratories includes those situated at Winnipeg and at Brandon in the Province of Manitoba, and at Indian Head and at Saskatoon in the Province of Saskatchewan, that is, in the principal grain belt of the world with an annual production of wheat, oats, barley, and flax to a value of well over $650,000,000. Some of the more serious diseases of these crops, such as smut, root rot, and flax wilt are largely controllable and to a considerable extent are being controlled. But the greatest problem, that of black or stem rust of wheat, remains. The

seriousness of this problem from the standpoint of national wealth will be realised from the statement that the annual losses from grain rust alone amount to as much as, and in some years treble, the return which Canada derives from its fisheries. Indeed, in 1916, the losses were estimated at more than $180,000,000, a sum equivalent to Canada's entire mineral production in 1922. A great deal of fruitful investigation under federal and provincial auspices has been conducted on this problem, especially on features directed towards a solution along the lines of resistance and immunity. As a means, however, of more quickly arriving at a complete solution, plans are taking shape for the consolidation of this work in a modern, fully equipped grain-disease research laboratory closely associated with one or other of our western universities. Such a laboratory would serve as a centre for research and would bring into close co-operation the staffs of the Canadian universities and colleges and the Honorary Advisory Council for Scientific and Industrial Research in an attack on the many intricate, fundamental problems connected with rust disease.

Besides the federal service to plant pathology special mention should also be made of the valuable work that is being carried on under provincial auspices and by the agricultural colleges and universities of the Dominion. At present only the Provinces of Manitoba and British Columbia maintain plant pathologists on their technical staffs, but all the principal colleges and most of the universities devote considerable time and attention to the more fundamental phases of scientific research and the provincial agricultural colleges have contributed much in other directions, such as extension and experiment station work. Moreover, to the universities and colleges both federal and provincial services must continue to look for the education and training of the young men who are to become their scientific officers. All of the workers in these various fields are unofficially kept in contact with one another by means of a thriving organisation, the Canadian Phytopathological Society.

Before leaving this part of the subject it is fitting that a brief account (contributed by Professor J. E. Howitt) should be given of plant pathology in the Province of Ontario. Experimentation in Ontario in relationship to the health of farm crops was begun as early as in 1890. Development has proceeded continuously from that time, keeping pace with the development of the various branches of agriculture and horticulture. A persistent effort has been made to make available to the grain grower, the fruit grower, the vegetable gardener, and the floriculturist the best means of combatting the various diseases to which their respective crops are economically subject. The accomplishments attained include—experiments and demonstrations in the

control of grain smuts, fruit and vegetable diseases, and in the preparation and application of specific fungicides; the control of peach yellows and little peach through an educational campaign and the compulsory destruction of diseased trees; the improvement of the potato crop of Ontario by making it possible for farmers to secure disease-free seed potatoes—a result brought about by co-operation with the federal Department of Agriculture in carrying out an effective system of inspection and certification of seed potatoes; the establishment of a field laboratory of plant pathology at the Experimental Farm located at Ridgetown for the study of the diseases of the special crops of the Essex peninsula; the publication of many and varied articles and bulletins. Plant pathology was first placed on the curriculum of the Ontario Agricultural College in 1898.

Forest pathology in Canada is as yet undeveloped, which at first sight seems surprising in view of the fact that the products of her forests rank second only in value to her agricultural crops and that the forests are potentially of enormous importance. But as long as most people believed that there was an unending supply of sound timber there was likely to be little time or money spent on the diseases of timber. Signs are not wanting, however, that the halcyon days of the stripping of Canadian forest resources, to the production of which man has contributed nothing, are drawing to a close. When they do, and crop production by whatever system is undertaken, pathology will be a handmaiden to forestry in America as in Europe, and just as it now is in every civilised country to agriculture. Meanwhile the pathological problems on the very fundamentals on which applications may be based await solution. The progress so far made recalls, in one respect at least, the situation in agriculture in Vankoughnet's time, as referred to above—the ravages of the more obvious insects have been generally recognised; the tremendous inroads of disease are apprehended only by few. To Canada's credit a substantial foundation has been laid in forest entomology.

Nevertheless a beginning has been made. Ontario has again been the leader, for under the direction of the Provincial Forester, Mr. E. J. Zavitz, forest pathological investigations have been in progress since 1918. The federal government has recently inaugurated a service devoted to the study of timber diseases, a few pulp and paper companies have employed pathological experts at various times to investigate specific problems, and the Dominion Forest Products Laboratory includes some pathological problems in its program of utilisation researches. Federal and provincial governments have

devoted considerable attention to the blister rust of five-needled pines, but unfortunately not until the disease was too well established in the east, and not soon enough to keep it out of the western forests.

The pathological problems of Canadian forests are as varied as the kinds of timber and of stands that cover the greater part of the country. Among the various types of problems, two groups are of peculiar interest, one bearing on the utilisation of our diseased virgin forests as we find them, and the other on the maintenance of healthy forests with sustained yield. Besides these and other major groups there are hosts of intensely interesting "minor" problems, presumably oftener of scientific than of immediately apparent economic importance, but answers to which would at the least satisfy the curiosity of inquiring foresters and operators and at the same time materially add to the stores of biological science.

At the outset we are confronted with the multiplicity of fungus diseases of which even the mycology is unknown. True, some of the diseases prevalent here occur in Europe, such as the pecky heart rot of conifers (caused by *Trametes Pini*), a brown butt rot of some conifers (caused by *Polyporus Schweinitzii*), a white heart rot of broad leaved trees (caused by *Fomes igniarius*); but many are different, just as the hosts are different on the two continents. This fact has been amply demonstrated in the course of studies conducted by the Ontario Forestry Branch and the University of Toronto in co-operation on the diseases of a pulpwood species, the balsam fir. Of the several trunk diseases to which balsam is subject, the cause of every one, with a single unimportant exception, was unknown, and the determinations in every case have established new connexions. What is true of balsam is also true of many other Canadian species.

The ordinary problems of pathology in reference to the utilisation and the conservation of harvested timber are so universally present that any statement concerning them is unnecessary. They comprise problems of stain and decay in timber occurring in the forest, or at any stage following up to that of consumption. In a country such as Canada, however, where there are extensive areas of over-mature forests, or forests prematurely and much diseased following on injuries from fire or insect depredations (such as by the spruce bud-worm) pathological problems assume an importance not realised by those not brought into immediate contact with them. Thus there are large areas of spruce severely affected with the pecky heart rot; there are hundreds of square miles of balsam fir forests so riddled with a red heart rot (not even described in the literature outside of recent reports) that losses in operations run or would run well over fifty per cent., there are stands of birch, perhaps not less in extent, weakened to the point of

worthlessness from a heart rot that appears to be due to the true tinder fungus, and similar conditions exist in some of the maple stands of Ontario, and in the cottonwood and coniferous forests of the west. In the past such losses have been taken as a matter of course, but where timber supplies are waning the possibilities of utilisation are beginning to be explored. By way of example, important experimentation in this direction in connexion with pulpwoods is under way, and laboratory results indicate that for pulping purposes enormous amounts of spruce and balsam, now culled or left uncut as valueless, are capable of yielding chemical newsprint pulp, in bulk equal to or little less than what is obtainable from sound wood. The magnitude of such problems is only beginning to be appreciated.

Independent of the utilisation problems, yet more or less interlocked with them, are the more fundamental ones in connexion with the subject of the maintenance of healthy forests of sustained yield. These are being attacked from two directions, the parasite or other causal agent, and the host tree. In the first instance the inquiry is as to the identity of the fungus species or other factor responsible for any particular disease, and if the former, a determination of the source of the germs or spores that spread the disease. If perchance they are located on slash, then slash disposal finds a place among the means of control to be considered. On the other hand the question of the relation of the age of the host to immunity from attack of various fungi (or serious injury from certain other factors) is given a prominent place. Apparently trees are immune to many of the most serious diseases up to the time of approaching maturity, up until they are of merchantable size, up, let us say, until they are 60 or 70 or 100 years or older. If, therefore, the age at which they lose their immunity can be determined, a cutting cycle can more readily be established that will assure a maximum yield consonant with a forest of maximum health. One of the first studies along this line was initiated in Quebec, in the summer of 1922, by Mr. W. E. Hiley of the Oxford School of Forestry.

There remains one vital phase of plant pathology in Canada to which reference should be made, namely plant pathology in relation to Canada's international exchange of living plants and plant products.

One of the first problems dealt with by the newly organised Division of Botany in 1909 was that of protecting Canada against the entrance of the European potato canker disease. The matter was precipitated as the result of a fortunate discovery made by the Dominion Botanist of the existence of this disease in Newfoundland, where pre-

sumably it had been but recently introduced and established, as up to that time its presence in America was unknown. Apprehending that the extensive trade in potatoes between Canada and Europe might also result in its importation into Canada, a very active educational campaign was at once instituted throughout the length and breadth of the Dominion. This action was followed by the promulgation of an Act directed against the importation into Canada of destructive insects and diseases from abroad, the Destructive Insect and Pest Act, 1910, the first Act of its kind in Canada except for one that had been solely directed against the San José scale.

The Destructive Insect and Pest Act has proved remarkably efficient in accomplishing the purpose for which it was designed; thus the European canker was kept out of Canada and the Dominion still remains free from it. The Act is brief and concise, and conveys almost unlimited power, which, however, cannot be abused by a too eager administration, since the regulations made thereunder are passed upon by a special advisory board after having been thoroughly discussed with representaitves of the various outside interests concerned.

The Act, briefly, is directed against the introduction or spreading of insects, pests, and diseases destructive to vegetation, and provides terms or conditions for the importation of plants or plant products into Canada, or for the prohibition generally, from any particular country or district thereof, of the introduction or admission into Canada of any vegetable or other matter likely to introduce any such (destructive) insect pest or disease. Under its regulations it also provides for the treatment or destruction of any plant, or the containers thereof, which may be found or suspected to be infected with, or constitute an obstacle to (*vide* the barberry), the successful control of any pest or disease, etc., etc.

The Act is administered jointly with the Entomological Branch, by the plant pathological service of the Experimental Farms Branch, and as far as the Continent of America is concerned, very closely co-operates with the United States in the common interest of both countries.

While such restrictive measures are absolutely necessary and have abundantly demonstrated their value, may we express the hope that at some time in the future the question of protection against foreign pests and diseases may be dealt with on broader grounds than at present. By international agreement it would seem that workable measures prohibiting the *exportation* of diseased plants and plant products might be enacted. This plan coupled with the observance of certain standards as regards quality would have definite salutary effects in all countries subscribing to such measures. The adoption of standards of quality

would of itself constitute a most desirable factor in restricting importations of a class and quality of merchandise to which no country could take exception on biological grounds.

Meanwhile, all countries more or less selfishly continue to make matters more difficult by stringent regulations. That there will be an enlarged international policy on this question in the near future among the nations of the world is not to be expected. But it may not be too much to hope that the nations comprised in the British Empire will formulate and adopt effective measures along the lines suggested applicable to trade within the empire.[1]

[1]For bibliography see appendix.

THE FORESTS AND FOREST INDUSTRIES OF CANADA

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General Conditions.—The land area of Canada is 3,600,000 square miles. Since much of the area has never been thoroughly explored, only estimates can be made of the extent to which it is covered by forests. Making deductions for the estimated extent of the barren lands in the extreme north, the prairies and plains of the central region, the mountainous area above tree-line in the west, and deductions for the known extent of land under agriculture outside of the prairie region, we derive the statement that approximately one half the total land area is without tree growth. Furthermore, this enormous area of 1,800,000 square miles of forests must be still further delimited, when considered from the standpoint of commercial material, since there are very extensive areas in the subarctic and subalpine regions which do not support trees in sufficient quantities or of sufficient size to make their utilisation profitable, even for pulpwood. Such eliminations would reduce the total forest area, as given above, by one-half and would thus give the estimated area of commercial forest (containing trees of pulpwood and sawlog size) as 900,000 square miles. A still further reduction must be made on account of the destruction of standing timber by forest fires, and again it is well within the limits of probability to make the divisor two. In other words, during the past seventy-five years at least one-half of the commercial forested area has been burned. It takes that length of time, under the average forest conditions in the north country, to make a spruce tree of pulpwood size, that is, six inches in diameter on the stump. Therefore, the burned areas as a whole do not now contain merchantable trees. The fact that the majority of such areas have been burned not only once, but several times, removes them still farther from the merchantable class.[1]

Thus, by a series of eliminations, we come to 450,000 square miles as the area in Canada to-day, yielding commercial timber, that is, sawlogs and pulpwood. The sawlog producing forests are in two great groups; in the east (Ontario, Quebec, and the maritime provinces) and in the extreme west (British Columbia and Alberta), separated by

[1]For the composition and distribution of the forests the reader is referred to the contribution by Professor F. E. Lloyd.

the treeless prairies, while the pulpwood-producing forests are continuous from coast to coast, extending northward of the Atlantic and Pacific sawlog forests and the open grasslands of the interior.

It will be seen that the present stands of commercial timber cover only 12.5 per cent. of the total area of the country and that this percentage is doubled by including the potential timberlands represented by the burned areas.

Estimates of Forest Supplies.—The estimates of Canada's resources in commercial timber are based mainly upon reconnaissance surveys and therefore cannot be considered as estimates in the technical meaning of the term. Perhaps the most reliable of these is that for British Columbia, made by the Commission of Conservation. The same organisation made a report upon the forest conditions of Nova Scotia and Saskatchewan. The Province of New Brunswick has in progress a very careful and detailed estimate of its standing timber. Both the Dominion Forestry Branch and the Provincial Forestry Branch have been at work for several years on a timber survey of Ontario. The Forest Service of Quebec is methodically gathering data on the timber supplies of that province.

ESTIMATE OF THE FOREST RESOURCES OF CANADA

Province	Saw Material in million feet board measure			Pulpwood in million cords		
	Soft-wood	Hard-wood	Total	Spruce, Balsam, western hemlock	Jack pine, eastern hemlock, poplar	Total
Quebec	80,000	10,000	90,000	200	100	300
Ontario	49,500	5,500	55,000	185	65	250
New Brunswick	9,000	6,000	15,000	21	5	26
Nova Scotia	6,500	3,500	10,000	25	6	31
Eastern Canada	145,000	25,000	170,000	431	176	607
Alberta	11,500	7,000	18,500	63	129	192
Saskatchewan	4,000	4,000	8,000	31	117	148
Manitoba	3,500	3,000	6,500	26	54	80
Prairie Provinces	19,000	14,000	33,000	120	300	420
British Columbia	350,000	750	350,750	250	20	270
Total	514,000	39,750	553,750	801	496	1297

Generalising from the information obtainable from the various provinces, Mr. Roland Craig of the Dominion Forestry Branch presented the above estimates to the Imperial Forestry Conference held in Canada last summer. The taking of these figures at their face

value will bring out some interesting facts. For example, they would indicate, at the present rate of cutting, about 100 years' supply of softwood (coniferous) sawlog material and 260 years' supply of pulpwood. About one-third (28 per cent.) of the softwood sawlog supplies, however, are in eastern Canada (Ontario, Quebec, and the maritime provinces), which contains more than two-thirds of the population and is much nearer the great export markets. Over 60 per cent. of the softwood supply is in British Columbia. Dividing the estimated supply of softwoods in the east, by the average production during the last ten years, we find the supply sufficient to last about 45 years. This estimate makes no allowance for destruction by fire, or by insect and fungous diseases which in the aggregate undoubtedly far offsets

FIG. 22. LOGGING CAMP IN NORTHERN ONTARIO
The background shows typical white pine forest with under-storey of paper birch.

the annual increment of growth. It may be interesting to note, in this connexion, that the supply of softwood saw-material for the whole of Canada as given in the table would last the United States only ten years at their present rate of consumption.

The figures in the table of pulpwood supplies need some interpretation. The first vertical column refers to materials now in use in the manufacture of pulp and paper, the second column to materials not now in general use but which may be utilised when the better grades represented in the first column are approaching exhaustion. Therefore, amounts in the second column may be regarded as reserves, and,

as will be seen, they constitute more than one-third of the estimated supply of pulpwood. Little more than one-half of each class of materials as shown in the first and second columns is to be found in eastern Canada. Furthermore, no deduction is made in the figures as given in the table for non-accessibility. For example, much of the pulpwood in British Columbia is high on the mountain-sides and will always be difficult and costly to harvest, and in eastern Canada much of the pulpwood included in the estimates runs less than two cords to the acre and lies in the Hudson Bay drainage basin. This timber is so far from the markets and so widely scattered that it will not be available until the price of pulp and paper is much higher than at present.

Ownership and Regulations.—The forests of Canada, with the exception of the farm wood-lots and a comparatively small area of timberlands in private holdings, are the property of the Crown as represented by the Dominion and the several provincial governments. The Dominion government owns the forest lands in Manitoba, Saskatchewan, and Alberta, and the so-called Railway Belt in British Columbia, a strip of land 20 miles wide on each side of the Canadian Pacific railway and comprising about 11,000,000 acres. The total forest area indicated above is approximately 117,000,000 acres, of which 22,000,000 acres have been organised into forest reserves and are administered by the Forestry Branch at Ottawa, whose staff includes twenty technically trained foresters.

British Columbia, outside of the Railway Belt, has some 200,000,000 acres of forest under Crownland administration. Ontario has in the neighbourhood of 100,000,000 acres under the Crown, outside of the District of Patricia (130,000,000 acres). In Quebec some 125,000,000 acres of forests are under Crown control, exclusive of Ungava with an estimated area of 225,000,000 acres, while in New Brunswick the Crownland forests aggregate around 8,000,000 acres. Nova Scotia's forests, as well as those of Prince Edward Island, are practically all under private ownership. These give an aggregate of 444,000,000 acres of forest lands in Canada which are administered with reference to fire protection or timber-cutting regulations, or both, by the Dominion and the various provincial forestry organisations, which together employ about one hundred technically trained foresters and several thousand fire rangers.

The Dominion and the various provincial governments by tender or by public auction sell the right to cut timber. The purchaser of such rights, usually before his woods' operations begin, pays a certain sum, called a bonus, for the standing timber, and in addition he pays a fixed rate, called dues, per thousand board feet or per cord, for what he actually cuts. The amount of bonus naturally depends on the

Fig. 23. FOREST OF DOUGLAS FIR, BRITISH COLUMBIA Courtesy of C. C. Pemberton

quality of the timber and its accessibility. As high as $20 per thousand feet, Doyle scale, has been paid for white pine. The dues in each province vary with the different classes of timber, and those levied on the same class of timber vary, in the different provinces, from fifty cents to $3.50 per thousand board feet, and from ten cents to $1.50 a cord for pulpwood. In addition to the above, the operator pays an annual ground rent for the use of the land, in most cases at the rate of one cent per acre.

The gross revenues derived from the forests in 1921 were as follows: Ontario, $3,763,440; Quebec, $3,035,360; New Brunswick, $1,081,418; British Columbia, $1,544,251; Dominion forest reserves, $248,719; a total for the whole country of $9,673,188.

The license to cut sawlogs is renewable each year in British Columbia, Ontario, and Quebec; and at a period of twenty years in New Brunswick. The Government in all cases, except in British Columbia, reserves the right to change regulations and to adjust duties at its discretion, but, in actual usage, this is done only at intervals of three to five years, and only at the expiration of at least a year from the publication of intentions. In British Columbia, when the market value of lumber goes above a certain price agreed upon as furnishing the producer a reasonable profit on his investment, the royalties exacted by the province increase in definite ratio. The adjustment is made at five-year periods and is based on the average price of lumber during the previous three years. In this manner the public shares in increasing timber values.

Fire Protection.—As early as in 1849, we have the records of the protests of lumbermen and other public-spirited men against the useless destruction of timber by forest fires, and the matter was called to the attention of provincial legislatures in 1859 and again in 1867. The Province of Ontario in 1878 passed an Act to preserve the forests from fire, which contained provisions for establishing fire districts, for regulating the use of fire for any purpose in the forest, and for installing spark arresters in railway locomotives. This was one of the earliest, if not the earliest, forest fire prevention act on the continent, and was the model on which several American states based their legislation in this matter. Ontario established a fire ranging and patrol system in 1885, again one of the first on the continent. The other eastern provinces followed Ontario's example, both as to legislation and as to the patrol system. Ontario has spent more money on forest protection than any other province and it has, to-day, the largest, best equipped, and most efficient organisation under government control.

In Ontario, with which the writer is most familiar, the cost of fire ranging was at first shared equally by the government and the

limit holder, then for a period, the lumberman was assessed for the cost of fire fighting and patrol on his territory, and finally, he was taxed at the rate of one cent an acre per year on his holdings. This fire protection tax, however, pays only a portion of the actual cost.

Aircraft are now extensively and successfully employed in aerial patrol in nearly every province, and they are occasionally used in the transportation of men for fire fighting. Some of these craft are equipped with apparatus for wireless telephony. The hydroplane or seaboat is the type of aircraft employed, as it is well adapted for use in a country where lakes are so plentiful as in eastern Canada. The frequency of bodies of water, also, makes possible the successful use of gasoline pumps in the actual fighting of fire. Special portable types have been developed for this kind of work. Some of them will work effectively with nearly a mile of hose.

The early systems of fire protection employed only a few men and cost only a few hundred dollars, but they have expanded as necessity required until now Canada expends close to $3,000,000 a year and employs about 3,000 men in the protection of her forests. Candor impels one to add that the good intentions of the early fire-ranging organisations were soon lost in the slough of political patronage, and they floundered there for too many years. They are happily emerged now and the protection of the forests from fire, so far as the administrative organisations are concerned, is a very earnest and serious business, but, unfortunatley, it still lacks adequate support and co-operation on the part of the public—even to a proper comprehension of its value and economic significance in relation to the continuity of the wood-using industries.

The Lumber Industry.—The lumber industry of Canada began, naturally enough, with the supplies most accessible to the early settlements and progressed inland along the great water highways as did the settlement of the country. Lumbering on a large scale apparently began in Nova Scotia. As early as in 1760 thirty saw mills were operating, producing in all more than a million feet of lumber. The leadership in production passed to New Brunswick about 1800, to Quebec about 1860, and to Ontario in the early 'nineties. Since 1912, with some fluctuations, British Columbia has produced more lumber than any other province in the Dominion. Indeed, one-third of the total production of sawlog material is now in British Columbia, and, moreover, British Columbia fir, transported nearly 3,000 miles, competes successfully in the Toronto and other eastern markets with the native pine and spruce lumber.

It is evident that the lumber industry could not have begun to develop so early and could not have maintained its constantly growing

proportions without access to outside markets. The earliest markets were, of course, in Europe, and the first record of exports in any considerable quantity dates back as far as 1667 in the French régime. A great impetus was given to the export of pine to the United Kingdom by Napoleon in closing the continental ports to British trade. During this interval, Canadian pine so thoroughly established itself on the British market that it successfully competed with Baltic pine when international trade was restored. It maintained its lead even after the inauguration of the British free trade policy in the 'forties, notwithstanding the advantage of Baltic shippers in their proximity to the British market and the consequent lower transportation charges. The progress of this trade is exhibited by the following statement: In 1802, Quebec ports sent to the United Kindgom 250,000 cubic feet of pine, and in 1864, 20,000,000 cubic feet, the latter valued at about £3,000,000.

The export of pine to the old country was almost entirely in logs in the form of square or waney timber. From this time, the trade with the United Kingdom in unsawn logs has steadily decreased until now it is relatively negligible. This decline was partly due to the failing supply of large pine logs, partly to changed market conditions in Great Britain, but most of all to the development of a much nearer and less exacting market in the United States. The demand from that source was chiefly for sawn lumber and it was soon perceived that catering to such a market was more profitable to the operator and at the same time more stimulating to home industries. The proximity and the capacity of the United States markets made possible the remarkable development of the pine lumbering industry in eastern Canada during the last decades of the nineteenth century. About the time of Confederation, the value of the exports to the United States exceeded those to the United Kingdom. Since that time, the greater part of the products of the saw mills and the output of the pulp and paper mills has gone to the southward.

Owing to the incompleteness of the early records and to the changing standards of measurements, it is hardly possible to give an accurate estimate of the amount of white pine produced in eastern Canada, but it would doubtless extend to several hundred billion board feet. White pine has probably contributed more to the wealth of the country than all the other lumber trees combined. Relatively speaking the supply is rapidly approaching exhaustion. The decline in production began to manifest itself 30 or 40 years ago, being noticeable in the maritime provinces in the early 'eighties and in Quebec and Ontario about 1900. At the present time, Ontario is cutting a half billion feet less white pine than it did 25 years ago. At the present

rate of cutting the virgin supply will last about 25 years. There are considerable areas of young-growth white pine in eastern Canada. They constitute a valuable asset, but, unfortunately, they are being greatly reduced each year by repeated forest fires.

As white pine became less accessible, the lumberman turned to its best substitute, spruce. This lumber began to appear on the markets in considerable quantities about in 1880. Since 1888 more spruce than pine has been cut in New Brunswick. Spruce has surpassed pine production in Quebec since 1900. Ontario has always cut more pine than spruce. The development of the pulp and paper industry in later years has made great demands upon the spruce forests. The decline in accessible supplies began to be apparent about fifteen years ago when balsam fir was first used as a substitute, although considered to be inferior material for pulp and paper purposes. Operators who, at that time, would not use balsam fir, to-day do not discriminate between it and apruce. About a half-million cords of balsam fir are now used each year.

Another indication of the passing of adequate supplies of spruce is to be found in the experiments in the use of hardwoods for groundwood pulp, and in the conversion of the plentiful and cheap jack pine into sulphite pulp.

As is the case with white pine, there is not an adequate natural regeneration of the spruce forest after the cutting operations, and little or no conscious effort is being made by the administrative organisations to direct the natural regeneration towards the re-stocking of the cutover lands with the commercially valuable species.

The forests of Canada from the earliest times have attracted lumbermen from the United States. For many years logs were cut from Crown lands and exported for manufacture in the lake ports of Michigan, Ohio, and New York, and in the New England sea ports. With the depletion of the Michigan pineries, about 1890, the logging industry of the lake states migrated extensively to Ontario while the manufacturing still remained south of the international border. Since population usually follows raw material to the place of manufacture, the Ontario legislature, in 1900, passed regulations requiring all softwood timber cut on Crown lands to be manufactured within the province. Nearly all the other provinces enacted similar legislation within the next ten years, and, as a result, many saw mills moved into Canada from the United States.

The table below sets forth the average production of lumber in Canada, for a five-year period, its value, and the extent to which the five leading kinds of timber have contributed. Then follows a statement for each province, its rank in the Dominion, the five leading timber species and their rank within the province.

Annual Production of Lumber
Average, 1916-1920 inclusive

Leading species	M. board feet	Per cent. of total
	Canada 3,930,252 M. board feet[1] $107,224,031 value	
Spruce	1,355,081	34.5
Douglas fir	742,871	18.9
White pine	688,201	17.5
Hemlock	265,839	6.7
Cedar	133,156	3.4
	British Columbia 1,168,345 M. bd. ft.—29.5% $30,000,642 value	
Douglas fir	742,810	63.6
Cedar	103,086	8.8
Spruce	96,175	8.2
Western yellow pine	70,178	6.1
Tamarack	42,584	3.6
	Ontario 1,009,495 M. bd. ft.—25.7% $30,855,008 value	
White pine	533,367	53.0
Hemlock	105,175	10.4
Spruce	93,668	9.2
Red pine	65,827	6.5
Maple	24,567	2.4
	Quebec 857,643 M. bd. ft.—21.8% $23,736,412 value	
Spruce	509,117	59.4
White pine	89,474	10.4
Balsam fir	59,125	6.9
Hemlock	52,068	6.1
Birch	41,241	4.8
	New Brunswick 512,631 M. bd. ft.—12.1% $13,349,882 value	
Spruce	371,513	72.0
Balsam fir	46,366	9.0
White pine	38,931	7.6
Hemlock	19,096	3.7
Cedar	11,513	2.3
	Nova Scotia 226,510 M. bd. ft.—5.8% $5,455,082 value	
Spruce	140,816	62.2
Hemlock	32,443	14.2
White pine	12,125	5.4
Birch	9,579	4.2
Balsam fir	7,437	3.3
	Saskatchewan 69,061 M. bd. ft.—1.8% $1,749,799 value	
Spruce	68,683	99.0
Tamarack	259	....
Poplar aspen	86	....

[1] M = 1,000.

Leading species	MANITOBA 50,929 M. bd. ft.—1.3% M. board feet $1,209,869 value	Per cent. of total
Spruce	48,517	95.2
Poplar aspen	509	1.0
Tamarack	339	0.7
Jack pine	216	0.4

	ALBERTA 30,353 M. bd. ft.—0.8% $690,264 value	
Spruce	24,112	79.4
Jack pine	2,599	8.6
Poplar aspen	333	1.1
Tamarack	105	0.3
Poplar balsam	75	0.2

	PRINCE EDWARD ISLAND 7,166 M. bd. ft.—0.2% $172,473 value	
Spruce	2,584	36.1
Balsam fir	1,815	25.3
Birch	503	7.0
Hemlock	288	4.0
Beech	187	2.6

It will be seen that spruce is the leading timber tree in the Dominion, the amount of its cut being nearly as great as that of any other two species combined. The term spruce, however, includes black spruce, red spruce, Sitka spruce, and white spruce. Until approximately twenty years ago, white pine, which now has third place, led in production. Ontario has produced the largest amount of pine for a great many years, and Quebec has led in spruce production. British Columbia, Ontario, and Quebec are the chief lumber-producing provinces. They fluctuate in leadership. In the past ten years British Columbia has led five times, Ontario three times, and Quebec twice.

The value of lumber, lath, and shingles produced in one year is $150,000,000. Lumber means boards, deals, and dimension stock—not the finished product. The total capital invested in this industry is $250,000,000; the number of employees is 55,000; and the annual wages $60,000,000. The minor industries, which depend entirely upon wood, produce materials to the value of $60,000,000 annually; they have an invested capital of over $50,000,000; they employ 13,000 people; and they pay annually about $14,000,000 in wages. To these industries should be added those which depend essentially, but not entirely, upon forest products. Such industries (*e.g.*, horse-drawn and motor-drawn vehicles) yield each year products valued at $86,553,314. The capital invested totals over $65,000,000 and the employees number over 9,000, to whom are paid wages amounting to nearly $12,000,000:

The Pulp and Paper Industry.—From the tables below it will be seen that nearly three-fourths of the pulp and paper production is from Quebec and Ontario, and that practically one-half of the pulpwood is cut in the Province of Quebec. Most of the raw pulpwood exported to the Unites States comes from Quebec. Ontario manufactures a much larger percentage of her product into paper and thus keeps the larger portion of the value of her pulpwood products at home.

The legislation with reference to the export of softwood sawlogs was enacted just at the time the pulp and paper industry was beginning to develop in eastern Canada, and when the requirement of home manufacture was enforced with respect to pulpwood concessions. We have here a splendid illustration of the value of legislation to stimulate home industries. In the early 'nineties the capital invested in pulp and paper manufacture in Canada was $3,000,000 and the value of the exports about $200. The embargo on the export of pulpwood from Crown lands brought American and British capital to Canada. The capital invested in the industry is to-day over $381,000,000, and the value of the output is $85,000,000 for pulp, and $106,000,000 for paper. The industry employs 33,000 men and pays them $40,000,000 a year in wages. In fact, the making of pulp and paper is the largest manufacturing industry in Canada to-day. About $120,000,000 of the $191,000,000 value of the pulp and paper products as given above is exported, mainly to the United States; and this item of export is the chief factor in maintaining the parity of exchange between the two countries. The pulp and paper industry has established thriving towns in the wilderness; it has produced an enormous volume of business; it has created millions in new wealth; its development in the past 25 years is one of the romances of modern industrialism.

ANNUAL PRODUCTION OF PULPWOOD
Average, 1916-1920 inclusive

CANADA
2,257,224 cords[1]
$26,712,198 value

Leading species	Cords	Per cent.
Spruce	1,636,367	72.4
Balsam fir	473,551	20.9
Hemlock	113,335	4.9
Jack pine	20,032	0.9
Poplar	7,686	0.3

QUEBEC
1,125,914 cords—49.8%
$12,382,418 value

Leading species	Cords	Per cent.
Spruce	747,840	66.4
Balsam fir	364,949	32.4
Hemlock	4,584	0.4
Poplar	3,262	0.3

ONTARIO
788,304 cords—34.9%
$10,617,628 value

Leading species	Cords	Per cent.
Spruce	713,195	90.4
Balsam fir	45,815	5.8
Jack pine	14,678	1.8
Hemlock	12,116	1.5
Poplar	2,499	0.3

BRITISH COLUMBIA
201,712 cords—8.9%
$2,312,635 value

Leading species	Cords	Per cent.
Hemlock	96,063	47.6
Spruce	84,427	41.8
Balsam fir	13,253	6.5
Poplar	1,054	0.5

New Brunswick 123,328 cords—5.5% $1,247, 919 value		
Leading species	Cords	Per cent.
Spruce	74,197	60.1
Balsam fir	48,448	39.3

Nova Scotia 17,965 cords—0.8% $147,597 value		
Leading species	Cords	Per cent.
Spruce	16,708	93.0
Balsam fir	1,085	6.0

[1]In addition to this the average annual export to the United States in the period was 1,150,653 cords, of which the value averaged $10,832,125.

ANNUAL PRODUCTION OF PULP AND PAPER
Average, 1917-1921 inclusive

Canada	Tons	
Pulp	773,185	
Paper	1,029,908	
Value $148,611,911		

Quebec	Tons	Per cent.
Pulp	449,618	58.1
Paper	438,042	42.6
Value $69,581,166		

Ontario	Tons	Per cent.
Pulp	189,662	24.5
Paper	475,242	46.1
Value $57,679,926		

British Columbia	Tons	Per cent.
Pulp	45,857	5.9
Paper	116,420	11.3
Value $14,385,143		

New Brunswick	Tons	Per cent.
Pulp	70,205	9.1
Paper	......	
Value $6,358,278		

Nova Scotia	Tons	Per cent.
Pulp	17,843	2.3
Paper	......	....
Value $569,145		

Reforestation.—Forest planting first received widespread public attention in Canada in a wave of enthusiasm for forest conservation that swept the North American continent in the late 'seventies and early 'eighties. From this beginning of 40 or 50 years ago, forest planting in Canada has developed steadily, with some notable peaks of purposeful endeavour as well as points of depression, until the area planted has been extended to about 50,000 acres. Much the greater part of this, however, is not really forest plantation, being shelter belts and small patches of waste lands on farms, especially in the prairie regions. The actual forest plantations for the purpose of timber production do not exceed 6,000 acres. This statement hardly describes the situation, however, for there has been a great increase in forest planting in the past few years. At least 2,000 acres have been planted within the past year.

While there are justifiable regrets over the present status of the forests in Canada, there should be no recrimination. The treatment of the forest has been determined by economic conditions, and therein has been repeated the history of forest exploitation in all industrial countries, while passing through the stage of development represented

FIG. 24. REPLANTING EXHAUSTED FARM LANDS, NORFOLK COUNTY, ONTARIO

FIG. 25. FOREST OF THIRTEEN YEARS' GROWTH, NORFOLK COUNTY, ONTARIO

The photographs for Figures 24 and 25 were taken from practically the same point at the Provincial Forest Station.

by small population, vast unoccupied spaces, and great undeveloped natural resources. In the midst of plenty there is no preservation and little conservation.

The economic conditions which brought about the devastation of the forests of Canada no longer exist, and the continuance of such devastation is an economic anachronism of great danger to the future industrial development of the country. Nature, in the distribution of climate, in the formation of soils, in the disposition of her waterways and water powers has predetermined that Canada, in order to reach the full stature of her industrial possibilities, should always be very largely concerned with the raising of forest crops for the markets of the world.[2]

[2]For bibliography, see appendix.

THE DEVELOPMENT OF THE PULP AND PAPER INDUSTRY IN CANADA

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The pulp and paper industry which to-day, from the standpoint of capital invested, occupies second place in Canadian industries, is practically a development of the twentieth century. Paper was made in Canada previous to that time, in fact its manufacture dates back to the first half of the nineteenth century, but the great expansion has taken place in the last twenty years. It is difficult to trace the early history of the pulp and paper industry in the Dominion, owing to the lack of reliable and authentic records. The earliest paper was a hand-made product, made from rags and other waste materials, and the paper industry of that time was regarded somewhat in the light of the scavenger of other industries, since its raw materials consisted mainly of waste substances for which no other use could be found. It was about the year 1860 when wood began to be used as a raw material for making paper and it was the discovery of the adaptability of wood to the purposes of the paper-maker that gave the great impetus to the industry.

The use of wood as a source of fibre for the manufacture of paper was first made commercially successful in central Europe about the middle of the nineteenth century. The first wood-pulp was produced by simply grinding the wood into small particles by means of grindstones and this is essentially the method of producing ground-wood or mechanical pulp to-day. The ground-wood was originally used as a filler in combination with rag pulp and its purpose was to enable the paper-maker to produce a cheap finished product, since ground-wood by itself has not a sufficient length of fibre to be suitable for making paper, a process which depends upon the felting or matting together of the fibres in order to produce a continuous sheet. The principal wood used for the production of this pulp originally was poplar but as the use of wood developed, it was found that spruce and balsam were much more satisfactory for the purpose. Poplar is still used in the manufacture of soda pulp, which was a later development of the pulp industry.

The first ground-wood mill on this continent was established at Curtisville, Massachusetts, in 1876. In Canada, the first wood-pulp mill was erected by Alexander Buntin at Valleyfield, the grinders for that mill being imported from Sweden. These grinders produced about two tons of pulp per day and utilised white maple wood. To-day our largest ground-wood mill produces over 400 tons daily and several newsprint mills produce considerably more for conversion into newsprint paper.

The treatment of wood by chemical processes followed closely upon the invention of ground-wood pulp and the pulp produced by these means rapidly assumed great importance. The pulp resulting from chemical treatment of wood has a longer fibre and considerably

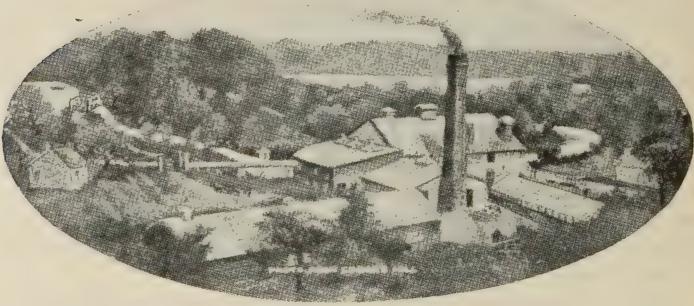

FIG. 26. PLANT OF THE ADAM CELLBOARD COMPANY, GREENSVILLE, ONTARIO

It is probable that the first mill in Ontario was built on this site, in Crooks' Hollow, 1813.

greater strength. Its use has gone far to replace the use of rags in the manufacture of book paper and many other finer grades. The first process to be developed was the soda process, so called from the method of cooking the wood in a solution of caustic soda. This was a more expensive process than the grinding method, the pulp produced, however, was light and bulky and was of great service as a "filler" in combination with pulp from other sources. The soda process has undergone considerable development in the United States but has not made very much headway in Canada, more attention having been paid in this country to the manufacture of mechanical and other chemical pulps.

The sulphite process for the manufacture of wood-pulp was worked out in 1866-67 in America, but was not at first a commercial

success. Later, in 1874, a Swede named Ekman, overcame many of the difficulties in connexion with the process and built the first sulphite mill in the world at Bergvik, Sweden. The Ekman process was introduced into America by C. S. Wheelwright and was put into operation at the plant of the Richmond Paper Co. Another method of producing sulphite pulp was developed by Rittner Kellner, an Austrian, and this process was used in the first sulphite mill established in Canada by J. R. Barber and Charles Riordon at Merritton, Ontario, in 1885. The introduction of sulphite pulp opened up new fields for the paper manufacturer and has been largely instrumental in the development of the industry to its present position. Pulp produced by this process is an excellent paper-making material and has to a very large extent supplanted the use of rags and other waste materials. The most modern application of sulphite pulp is its use in the manufacture of artificial silk, the annual production of which now exceeds that of the natural silk by an appreciable margin. The combination of sulphite pulp with mechanical pulp has also made possible the tremendous expansion in the newsprint industry which is to-day the leading branch of the pulp and paper industry in Canada.

The search for new materials for paper-making has long been carried on and is still continued. In the early days of paper-making in Canada a mill was established for the manufacture of wrapping paper from grass growing on the shores of Lake St. Pierre. A good grade of pulp was produced from this material and excellent wrapping paper was made therefrom. The introduction of the cheaper chemical pulp, however, caused the abandonment of this process owing to its expensiveness. Wrapping paper to-day is largely made from sulphate or "Kraft" pulp. Kraft pulp (from a German word meaning "strength") was first introduced by C. F. Dahl at Danzig in 1884. The first mill on the American continent to manufacture this grade of pulp was that of the Brompton Pulp and Paper Co. at East Angus, Quebec, which commenced operations in 1907 and still manufactures a considerable quantity of sulphate pulp annually in addition to other grades of pulp and paper. The development of this branch of the pulp industry may be seen from the fact that in 1922 there was produced in Canada 217,862 tons of sulphate pulp.

Closely connected with the early history of the pulp and paper industry in Canada are many names which are still well known in pulp and paper circles. The Toronto Paper Company was organised at Cornwall in 1881 and some of the digesters imported from Sweden for that mill were in operation as recently as 1918. The Rolland Paper Co. was established some forty years ago and still carries on the manufacture of bond, writing, and fine papers. The Maritime Sulphite

Fibre Co. at Chatham, N.B., became, later, the Fraser Company and is still owned by the Fraser brothers. The Canada Paper Co. is one of the old established firms as is the E. B. Eddy Co. of Hull. These and many other names have been well known in the industry during the last twenty or thirty years.

The pulp and paper industry of the early days, however, was a comparatively small industry. The population of Canada was not very great and the export business was insignificant. A good deal of the paper used in Canada was imported from abroad and the actual use of paper was very small. It has been estimated that in 1880 the per capita consumption of paper was about five pounds annually; to-day the per capita consumption in Canada of newsprint alone is about 34 pounds, while in the United States it is probably nearer 50 pounds annually. The vast resources of Canada in forests and water powers were hardly realised and little development had taken place. With the beginning of the twentieth century, however, began the rapid expansion of the industry which has brought it to the important position it now occupies in the economic and commercial life of the Dominion. From a country which made very little pulp or paper and which imported most of its supplies, Canada has progressed till it is now the world's leading exporter of these commodities and ranks second only to the United States as a producer of them. In 1890 the total exports of pulp and paper from Canada were valued at $120; in 1922 the total value of these exports was $115,873,742.

From 1908 onwards there is a fairly complete record of the growth of the industry so far as the consumption of wood and the production of wood-pulp is concerned. Detailed statistics for these years were published by the Forestry Branch of the Department of the Interior up to 1917, when the work was taken over by the Dominion Bureau of Statistics, which has issued annual census reports since that time. Unfortunately, the Forestry Branch reports were concerned only with the raw pulpwood and the manufacture of pulp and gave no information upon paper. We are, therefore, without authentic records of the production of paper until 1917, by which date the industry was well established. In the earlier years, however, newsprint was the principal grade of paper manufactured even as it is now.

The best index to the growth of the industry in this country is to be found in the figures showing the consumption of pulpwood by the domestic mills in the manufacture of pulp and paper. We have official records of this consumption as far back as 1908 and it will be seen that since that time the consumption of wood in our mills has increased rapidly until in 1922 it was more than six times as great as in 1908. Fifteen years ago our mills consumed 482,777 cords of wood in the

FIG. 27. PLANT OF THE FORT WILLIAM PAPER COMPANY, FORT WILLIAM, ONTARIO

A modern plant for the production of newsprint paper.

manufacture of pulp and paper; in 1922 the quantity used had risen to 2,912,608 cords. There were two important causes for this rapid growth. One was the prohibition of the exportation of pulpwood from Crownlands which was put into force by the provincial authorities in 1910. This action gave a big impetus to the domestic manufacture of this wood into pulp and paper and led to the establishment of many new mills in this country. Another cause was the rescinding of the tariff on pulp and newsprint paper by the United States, which threw open that market to our products. In 1907 there was considerable agitation among the publishers in that country against the high prices of newsprint and this agitation resulted in a tentative agreement on general trade reciprocity with Canada. This agreement was rejected by the Canadian parliament. One section of the measure, however, was so drafted that despite the rejection of the agreement, the United States so amended its tariff as to admit wood-pulp and printing paper (valued at not more than two and a half cents per pound) free of duty. With the greatest market in the world thus opened to these commodities the future of this industry in Canada was assured and our exports of wood-pulp and paper have increased steadily since that time. The following table of the annual consumption of pulpwood by the Canadian mills shows the rapid and continuous growth which has taken place in the industry since 1908:

CONSUMPTION OF PULPWOOD BY CANADIAN MILLS

Year	Cords	Year	Cords
1908	482,777	1916	1,764,912
1909	622,129	1917	2,104,334
1910	594,487	1918	2,210,744
1911	672,288	1919	2,428,706
1912	866,042	1920	2,777,422
1913	1,109,034	1921	2,180,578
1914	1,224,376	1922	2,912,608
1915	1,405,836		

It may be noted that the pulp and paper mills of Canada are mainly situated in the provinces of Quebec, Ontario, New Brunswick, and Nova Scotia. These are the provinces which have the greatest resources of forests and water powers. In British Columbia the industry is of later development, not through any lack of resources, for British Columbia is excellently supplied in that respect, but mainly because of the distance from the chief centres of population both in Canada and in the United States. Wood-pulp was first manufactured in British Columbia in 1909, when that province produced 644 tons out of a total for the whole of Canada of 445,408 tons. In 1922 British Columbia had risen to third rank among the provinces of Canada as a producer of pulp and paper.

The official report for 1909 shows fifty mills engaged in the manufacture of pulp in Canada in that year. No record is given of the number of these mills which carried the process further and made their pulp into paper. Spruce was by that time the mainstay of the industry and this wood has continued to furnish the larger portion of the pulp produced in Canada up to the present time. This wood, however, does not now furnish such a large proportion of the raw material as it did in earlier years. Balsam is now used in large quantities, while hemlock, poplar, and pine are also being used to a more limited extent. Scientific investigation and research, in course of time, will undoubtedly solve the problems of using other woods which at present are regarded as of little value by the paper-maker. Of the wood-pulp produced in Canada in 1909 nearly three-quarters was mechanical pulp or ground-wood, the rest being mainly sulphite pulp with a smaller quantity of soda-pulp. In that year, of the fifty mills reporting, 25 were in the province of Quebec, 10 in Ontario, 7 in New Brunswick, 6 in Nova Scotia, and 2 in British Columbia. The total amount of pulp produced was 445,408 tons and of this quantity 280,744 tons was exported, leaving 164,664 tons for further manufacture in the country. The principal countries to which this pulp was exported were the United States and the United Kingdom, while smaller quantities were sent to France, Belgium, and other countries. At that time almost twice as much pulpwood was being exported in

the raw state as was being manufactured into pulp and paper in Canada. It was not until 1913 that the domestic consumption of pulpwood exceeded the amount exported, a relationship which has been maintained ever since that year and one that is much more beneficial to the industrial life of the Dominion.

By 1911 the number of mills in Canada had increased to 54 and the production of wood pulp to 496,833 tons. Of the 54 mills operating during the year, 28 were in the province of Quebec. It was also recorded that experiments were being carried on in British Columbia in the manufacture of sulphite pulp and the small quantity of pulp produced in that province was mainly for experimental purposes. In that year

Fig. 28. DON VALLEY PAPER MILL, TORONTO, ONTARIO
A paper mill was constructed on this site by Taylor Brothers about 1840.

it was also noted that the increased manufacture of "Kraft" paper for which a few mills were being equipped, would result in a large production of soda-pulp.

The sulphate process was used practically for the first time in Canada in 1912 by three mills in the province of Quebec, which produced 33,469 tons of air-dry pulp. The process was introduced, as previously mentioned, by Dahl for the treatment of straw but was later adapted for use with coniferous woods. The three companies

producing pulp by this process were Wayagamack Pulp and Paper Co. at Three Rivers, Brompton Pulp and Paper Co. at East Angus, and J. C. Wilson Co. at St. Jerome. The sulphate pulp was used for the manufacture of wrapping paper, the process yielding a paper with considerable strength and resistance to tearing. In this year it was also recorded that the prejudice against balsam fir as a pulpwood was rapidly disappearing and that its importance to the industry would probably become greater as time went on, a prophecy which has been amply justified.

The development and growth of the industry in Canada proceeded rapidly during the next few years. The domestic consumption of pulpwood increased annually although the quantities exported showed little change. Canada was exporting each year larger quantities of pulp and paper (principally newsprint). Great developments were taking place in Quebec, Ontario, and British Columbia; New Brunswick and Nova Scotia were falling back; and British Columbia had stepped to third place.

In 1917 the first complete census of the pulp and paper industry of Canada was issued by the Dominion Bureau of Statistics and this report gave various items of information which had not hitherto been published but which were of great value to those interested in the development of the industry. Previous reports issued by the Forestry Branch concerned themselves almost solely with the consumption and export of wood and the production of wood-pulp. No records were available of the production of paper. In 1910, however, the production of newsprint which was the most important grade of paper manufactured in Canada was estimated at 215,000 tons and the output of this grade of paper gradually increased until the production in 1917 was 684,289 tons or more than three times as great. Of the production of other grades of paper there were no records previous to 1917 but the output was not large and these products were not prominent in our international trade.

The statistical report of 1917 showed 83 pulp and paper mills in operation in Canada with a total production valued at $96,340,327 showing that the industry by this time was well established and an important factor in the economic life of the Dominion. The capital investment represented by these mills in 1917 was given as $186,787,405; the average number of wage-earners was 21,400; and salary and wage payments totalled $20,358,019.

The total consumption of pulpwood was 2,104,334 cords, a considerable advance over the 482,777 cords consumed in 1908. The quantity of wood-pulp produced was 1,464,308 tons, the province of Quebec occupying first place, followed by Ontario, British Columbia,

New Brunswick, and Nova Scotia in that order. In that year there were produced 684,829 tons of newsprint, 15,292 tons of book and writing paper, 47,016 tons of wrapping paper, 51,784 tons of boards of various kinds, and 900 tons of other paper products.

Rapid expansion of the industry took place in 1919 and 1920, due in some measure to the general "after-the-war" prosperity and partly also to the unsettled condition of the countries of Europe. The Scandinavian countries and Germany were not in a position to supply their former markets with pulp and paper products and Canadian goods were in great demand throughout the world to make up the deficiency. This led to a large increase in the capacity of the mills and in production which continued until 1921, when the world-wide post-war "boom" collapsed with results that caused a serious set-back in industry everywhere. Towards the end of that year, however, the pulp and paper industry began to recover from its difficulties and as a result of the reorganisations and economies which were put into force, the year 1922 proved a very satisfactory one for the industry in general. The census of the pulp and paper industry for 1922 shows the strides made by the industry since 1917. Capital investment was

FIG. 29. PULPWOOD IN A QUEBEC RIVER
Courtesy of Price Brothers and Company, Limited.

now $381,006,324 or more than double of the investment in 1917. The number of pulp and paper mills in operation during the year was 104 and others were under construction which have come into operation during 1923.

The total consumption of pulpwood by the domestic mills in 1922 was 2,912,608 cords and from this wood were produced 2,150,251 tons of wood-pulp and 1,366,815 tons of paper, the total production being valued at $191,207,676.

A comparison of these figures with those for 1917 will show the development that has taken place during this period. Expansion is still going on and during 1923 several new mills have commenced production of pulp and paper while various other mills are under construction or are installing new machinery which will be put into operation in the near future. It will be only a matter of twelve months or so till Canada becomes the leading newsprint producer of the world and while our production of wood-pulp and other grades of paper has not expanded in the same proportions yet these products are becoming well-known in the markets of the world and are helping greatly to establish Canada's reputation as a pulp and paper producer.[1]

[1]For note on bibliography see appendix.

THE FISHERIES OF CANADA

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1. *Early Fishery Enterprises.*—The story of the fisheries of Canada reads like a romance. For over a thousand years, if Norse sagas are to be relied on, these North American waters have been recognised as abounding in valuable fish. Leif, the son of Eric the Red, after his long voyage across the Atlantic, ventured up the St. Lawrence, as recent Danish authorities affirm, and captured salmon, "larger and more plentiful than he had seen before". Doubtless, during the five centuries following, Norse and Spaniard, Portuguese and French, resorted to these prolific waters, but the first British craft to exploit the fisheries came in 1498, and it is worthy of note that as early as 1501 fishing companies were organised by the Portuguese to reap the "finny harvest" on these remote western "Banks". Prior to 1502 Breton and Basque fishing vessels, according to Fernandez de Navarette, had made valuable catches there, using hand-lines, he tells us, from barrels made fast outside the bulwarks, to avoid fouling against the sides of the vessels. Jacques Cartier observed, on ascending the St. Lawrence in 1534, a French fleet doing fruitful fishing for cod, while closer inshore the Indians were busy taking mackerel.

So valuable did the fisheries appear that, as early as in 1584, France proclaimed protective regulations for this fishery and organised a system of supplying the interior markets of Europe with cured cod. The first fish establishment on shore was founded by Chauvin in 1599 at Tadousac, about two hundred miles up the St. Lawrence river; but it was Nicolas Denys who, from 1633 to 1688, with the aid of his nephew, Pierre Denys, and some also of the French clergy, organised fishing settlements from Gaspé to Miramichi and really established the industry which has continued down to our own time. Almost from the first these North American fisheries assumed an international character, and as long ago as in 1691 there arose friction and jealousy among the different nationalities concerned, for, in that year, M. de Champigny made complaint that, though France owned the waters and was supplying the whole of Europe with salt cod, yet the English from Europe, with those from Boston and Manhattan, treated the fisheries as though they had rights in common with the French, and

from stations on shore shipped fish to the West Indies, the Mediterranean, and even to France herself.

2. *Further Development—The Jersey Firms.*—In 1764, the year following the Treaty of Paris, under which Canada became a British possession, the Jersey family of Robin took over the existing French establishments and developed the great fishing and curing industry, which has expanded and continued to the present day. Others from the Channel islands followed, and the admirable methods of catching the fish, and of curing them, led to an enormous business. In consequence, considerable fortunes were amassed. In their management of the fishing stations and the staffs of employés at isolated points on the lengthy coast, these fishing firms claim comparison with the enterprise and success of the Hudson's Bay Company in the fur trade. Cod was the only fish to which attention was given. Herring, mackerel, and other valuable kinds, were neglected for a long period of years. After the coming of the Loyalists from the United States, fishing villages grew up all along the Atlantic coast, but the communities on the more northerly parts continued distinctively French, the population being French Canadian, Acadian, or natives of the Channel islands.

In the sixteenth century, Sir Walter Raleigh felt justified in asserting that the North American fisheries were "the stay and support of the west counties of England". Early in the next century (1610), they brought two and a half million dollars annually to the English ports engaged in them, and they may still be regarded as among the greatest and most permanent of the Dominion's natural resources, and a prime source of wealth and food for the Canadian people.

The fishing fleets of the New England states, and of France and other nations, still share in these fisheries. Of course the territorial waters of Canada are open only to Canadian fishermen, but under the Treaty of Paris (1763) certain rights are enjoyed by France on the east shore of the St. Lawrence gulf. Fishermen of the United States have also certain rights under the Treaty of Ghent, 1814.

3. *Present Condition of the Fisheries.*

Atlantic Fisheries—The fisheries of eastern Canada may be conveniently divided into: (*a*) the deep-sea or "bank" fisheries, and (*b*) the inshore fisheries, the latter being mainly conducted in territorial waters.

The deep sea industry is carried on upon the famous North Atlantic "banks". These are elevated stretches along the sea bottom from "Brown's bank", off the western end of Nova Scotia, to the "Grand bank" south of Newfoundland. They lie from fifty to one hundred and fifty miles offshore. The "banks" include also numerous areas in the gulf itself around the Magdalen islands, and between

Cape Breton and Newfoundland. The total area of the banks exceeds, it is said, the area of Italy. Sailing vessels of sixty to one hundred tons engage in this fishery, carrying crews of twelve to twenty men. They fish from "dories", peculiar small flat-bottomed boats. Their daily catches they take to the vessel to be split and salted down. When the hold is full a return is made to port. Trawls or baited long-lines and baited hand-lines are used. Steam trawling, so important in the North Sea fisheries, has not been developed to any great extent, partly because the nature of the bottom is imperfectly known. Large quantities of fish, not in demand in the markets, are unavoidably taken. While cod are the principal fish handled, haddock, hake, pollock, and halibut are also captured plentifully. It is barely fifty years since a Canadian deep-sea fleet first resorted to the "banks". Fifteen vessels then sailed from Lunenburg in Nova Scotia. In recent years no less than seven hundred fine vessels, carrying also smacks, have sailed out of the principal ports, Lunenburg, Halifax, and Canso.

Important as are the deep-sea fisheries, those carried on within one to ten miles from the coast, or upon the foreshores, are still more important mainly from the fact that ten times as many fishermen engage in them. Many of these inshore men farm as well as fish. They use in their operations about thirty thousand motor boats, sail boats, and row boats. Small vessels up to forty tons and large motor craft with crews of two to five or six men operate within easy reach of shore, using gill nets, seines, baited hooks, and, for lobster-fishing, lath cages or "lobster traps", and, for oyster fishing, long-toothed tongs. Sedentary weirs of brush or wire, and mackerel and cod traps of strong net-twine, are fixed along the shore, and bag-nets, seines, and dip-nets are also used. Salmon, herring, mackerel, alewives (which are anadromous herring-like fish), smelts, shad, various species of flat-fishes, and small immature herring, mainly used in the so-called sardine industry, as well as lobsters, oysters, clams, scallops, etc., are all embraced in the inshore takes of fish.

Pacific Fisheries—On the Pacific coast in British Columbia, as on the Atlantic coast, there are the widely differing deep-sea and inshore industries. Although, during most of the period of over fifty years since these Pacific fisheries began, they have been synonymous with the salmon-canning industry, yet, in recent years, especially since about 1890, deep-sea fisheries have risen into importance, and in some years have reached nearly half the total value of the great salmon fishery.

Prince Rupert has become the central landing port for the great catches of Pacific halibut. Herring, flat-fish, many kinds of sea basses bearing a variety of names (including that of rock-cod), pilchard,

FIG. 30. BRITISH COLUMBIA HALIBUT

Unloading catch at wharf.

smelts, and other food-fishes are also included in the catches. Halibut form the main portion of the supply of sea fish, and the catch has trebled during the last fifteen years. In some seasons it has exceeded nine thousand tons. As with the Atlantic fisheries of Canada this Pacific halibut fishery has been very largely shared in by the vessels of the United States, but the most productive "banks" lie on the inner side of Queen Charlotte islands and in the Canadian portion of Dixon entrance.

The inshore fisheries of British Columbia have embraced many marketable kinds, but the salmon, including at least five species, has overshadowed all the others, and has constituted one of the greatest salmon fisheries in the world. All the estuaries along the coast of British Columbia from the Fraser river, on the south, to the Skeena, or rather the Nasse river, in the north, are the resorts of immense schools of incoming salmon, and four or five thousand fishermen secure their catches by means of drift or gill-nets, by seines, and, in some localities, by large traps set along the shore. From a total pack in 1876 of 9,847 cases, with 48 pounds to the case, the industry has grown to over 1,500,000 cases.

The Pacific whaling and sealing industries have a special character. They lie outside the fisheries proper and call for only passing reference. Two whaling stations on Vancouver island and two stations on Queen Charlotte islands are in operation. On the average, about five hundred whales are taken annually.[1]

Inland Fisheries—The immense area of the Great Lakes, really enormous fresh-water seas, and the unparalleled system of rivers and of lesser lakes, which diversify the three million square miles of Canada's land area, possess resources in fish which have stimulated fishing industries on an enormous scale. Lake trout, reaching a very large size, delicately flavoured lake whitefish, of from two to sixteen pounds in weight, lesser whitefish (erroneously called lake herring), sturgeon, pickerel or doré, closely allied to the European pike-perch, pike or jack-fish, perch, eels, and twenty other kinds, form the main catches. They have a total annual value of three or four million dollars, less than one-quarter of the value of the Pacific fisheries and one-fifth of the value of the Atlantic fisheries. There is ground for the opinion that, as half of the area of the Great Lakes belongs to the United States, Canada does not receive credit for large quantities of fish shipped out of the Dominion without being accurately recorded among the Canadian catches. It is agreed that the Canadian portion of the boundary waters are generally the more abundantly

[1]In 1919, 432 whales were taken in British Columbia, and in 1920 no less than 493 whales.

stocked with fish. Without doubt the inland fisheries are capable of great expansion. Vast lakes, such as Great Bear lake, Great Slave lake and hundreds of smaller lakes, at present inaccessible by rail, are known to abound in valuable fish. In time immense quantities of fish will be taken in these northwest waters and supply the principal markets of the continent. At present these rich but remote areas are utilised by the Hudson's Bay Co., traders, Indians, and Eskimos. Unexploited riches in fish are in the waters of Hudson bay, which is as large as the Mediterranean sea. The long stretches of sea along Canada's Arctic coast will also afford scope for great commercial development in the near future.

4. *The Fishing Population.*—In accordance with the fluctuations in the demands of the great markets, the fishing population has shown marked variation, and, at the present time, does not reach sixty thousand, whereas ten or twelve years ago it ranged between sixty and ninety thousand. On the Atlantic coast where the fishing villages occur at intervals from the Bay of Fundy to Gaspé and the North shore, the population, especially the French Canadians and Acadians, live a very primitive and hardy life, hardly touched by modern influences; but in busy fishing ports in Nova Scotia like Lunenburg, Canso, Halifax, Yarmouth, Lockeport, and Digby, everything is modern in respect to methods. The stations are well equipped with freezers, etc., of the most recent type. On the Great Lakes the fishing population is scattered, for the most part, in places all along the shores, and the fishing villages are few and small. Quite in contrast to this are the fishing centres of the Pacific coast. The salmon canneries are near isolated Indian villages, excepting New Westminster, Steveston, Prince Rupert, and a few similar centres. In the north, fishing activity largely ceases when the annual runs of salmon come to an end in the autumn, and the white employés, the Chinese, Japanese, Indians, and others return to their more or less distant homes. During many months of the year these fishing centres are quiet and deserted. The development of the sea fisheries, in contrast to the salmon fisheries, has stimulated activity during the whole year, and towns like Prince Rupert, Bella Coola, and other communities already mentioned carry on various branches of the industry from winter to autumn. Fishing towns and a numerous resident population, so long lacking, are now developing. Some of the British Columbian fishing ports possess the largest and finest types of fish establishments, with refrigerators, oil and manure factories, etc. On the Pacific coast the salmon canneries have always been spacious, well-equipped with modern machinery, and operated on the most admirable lines. It is worthy of note that at a few inland fishery centres similar great enterprise has been shown,

an example being Selkirk, on the Red river, Manitoba, where the freezers and fish houses for handling the vast quantities of fish from Lake Winnipeg and from other lakes have been among the largest and best in the Dominion. On the Atlantic coast more primitive methods long prevailed, and even now the many hundreds of lobster-canning establishments are small and often scantily equipped, but fine buildings of the most recent type have been erected at Canso, Port Hawkesbury, Halifax, Lockeport, Digby, and other ports.

5. *Value of the Fisheries.*—The annual returns yielded by the fisheries are so considerable as to rank this great Canadian industry among the most valuable in the world. Only the fisheries of Great Britain and of the United States exceed in annual value Canada's fisheries. It is interesting to compare the total production annually for a period of ten years, 1912-1922, with the annual exports.

ANNUAL VALUES, PRODUCTION, AND EXPORT OF FISH

Year	Value of Total Production	Value of Exports	Ratio of Exports to Production
1913	$33,389,000	$16,353,000	48.9%
1914	33,208,000	20,624,000	62.1 "
1915	31,265,000	19,687,000	63.0 "
1916	35,861,000	22,378,000	62.4 "
1917	52,312,000	27,778,000	53.1 "
1918	60,251,000	35,578,000	55.7 "
1919	56,508,000	46,495,000	82.3 "
1920	49,241,000	36,608,000	74.3 "
1921	34,932,000	30,146,000	86.3 ".
1922	41,800,210	28,558,546	67.4 "

The value of the fisheries for last year (1923) is estimated at about $40,000,000. In spite of the large scale on which the fisheries are conducted there is ample scope for expansion. The domestic market in Canada is far too limited, and the consumption of fish is probably not more than twenty-five pounds *per capita* annually. The chief obstacles to greater demand are the distances of the chief cities from the sea coast or the inland lakes, especially the western lakes, and the consequent high cost of fish to the consumers. The Dominion government has made efforts to remedy this state of things by providing more rapid rail transit, and by energetic publicity campaigns, and the distribution of "Fish Cook-books". Assistance was for a time given by the government to the extent of one-third of express charges on Atlantic fresh fish to points in the provinces of Quebec and Ontario, and from British Columbia ports to towns as far east as Winnipeg. A guarantee to the railways to the extent of two-thirds of the maximum car-load rate encouraged shippers to send fish in cold storage by fast

freight to principal centres in the interior of Canada. By these steps the attempt has been made to increase the domestic demand for fish.

6. *Capital Invested in Fisheries.*—The total amount of capital in the industry, in nets, boats, vessels and gear, as well as in curing houses, freezers and canneries, amounted to $54,694,026 in 1919, as compared with $50,405,478 in 1920, of which latter amount four-fifths were invested in sea-fishing operations, and one-fifth in the fresh-water fisheries. This is about six times the amount of capital invested in the fisheries a quarter of a century ago, but the value of the annual catches has, on the average, only about doubled. The annual returns twenty-five years ago averaged twenty million dollars, as compared with returns of thirty or forty million dollars, or thereabout, at the present time.

7. *Administration of Fisheries.*—At the federation of Canada in 1867, a federal Department of Marine and Fisheries was created under a cabinet minister as its head, and a very complete system of conservation and supervision was adopted, with great benefit to the fishery resources of the Dominion. It included a method of licensing which gave effective basis for official control. From time to time some of the provinces claimed still, as against the federal government, to hold important rights, and "test cases" were tried in the Canadian courts with a view to the removal of uncertainty as to provincial interest in the fisheries. The issue was comparable to one on "State Rights" in the United States. The first claims had reference to leases of salmon rivers. Owing to the increasing value of angling privileges, much sought after by wealthy citizens from the United States, control was keenly desired by the governments of Quebec and New Brunswick. Prince Edward Island asserted ownership as against the Dominion over her famous inshore oyster beds. The matter was referred to the highest judicial tribunal in the Empire, the Privy Council, London, which gave its decision in 1908 that on the one hand "property" in Dominion fisheries generally was vested in the provinces, with certain exceptions, such as the fisheries in public harbours, but that, on the other hand, "jurisdiction" over the fisheries belonged to the Dominion. It cannot be said that the decision cleared up all ambiguities or conferred any advantages on the fisheries as a great natural resource.

There are ten principal ways in which the federal government carries out the conservation and supervision of fisheries, etc.

1. Fishery laws and regulations providing for close seasons, the protection of immature fish and of spawning beds, prohibition of pollutions, obstructions, etc., and conditions respecting kinds and amount of gear.

2. Fishery leases and licenses (although certain provinces now issue these).

3. Fishing bounties to deep-sea fishermen, derived from a sum of $4,500,000 paid by the United States to Canada under the Halifax Award (November 23, 1877).

4. Improvement in curing and canning methods under a Fish Inspection Act.

5. Fisheries intelligence bureau, which, from a series of stations, announces bait supplies and movements of important fish in the coastal waters.

6. Publicity and educational scheme including lectures and publications, and demonstration methods in canning lobsters, curing fish, etc.

7. Government rebates and assisted transportation of fish from the coast to inland markets.

8. International conferences and schemes of research, and international co-operation in the survey of Atlantic and Pacific fishing grounds, including scientific studies of the movements and habits of fish. Such co-operation is very intimate with the United States, but it also embraces conjoint work with other countries.

9. Fish-culture, hatcheries, and stocking operations, on an extensive scale. The amount expended is not less than $350,000 per annum. In 1921 the total of fry and fingerlings distributed exceeded 845,000,000.

10. Scientific and technical researches conducted under the Biological Board of Canada. The Board includes the Dominion Commissioner of Fisheries and biologists representing the principal universities, as well as representatives of the fish trade. The Atlantic Biological Station at St. Andrews, New Brunswick, and the Pacific Station at Departure bay, Vancouver island, are the chief centres of the Board's researches, but problems are investigated on the Great Lakes and on western waters, and extensive surveys on the Atlantic waters are included.

8. *Canadian Fishes of Special Scientific Interest.*—Apart from the interesting lake whitefishes (*Coregoni*) and the peculiar salmonoids abounding in British Columbia waters, which belong not to the genus *Salmo* but to the genus *Oncorhynchus*, there occur somewhat abundantly in the Great Lakes the highly interesting ganoid *Lepisosteus*, the bony pike, and *Amia*, the bow-fin or lake dogfish; neither of these fish has economic importance or food value, and as they are captured, at times, in quantity, they are regarded as a nuisance by the lake fisherman. They are among the last remnants of an ancient type of armoured fishes abundant in the Devonian and Carboniferous ages, and have unusual interest for the scientific man. It is interesting to note that, at rare intervals, fine specimens of the curious paddle-fish,

Polyodon, have been captured in western Ontario. The fish is still found in some abundance in the Mississippi basin. Three or four species of sturgeon (*Acipenser*) are also taken in certain lakes and rivers, and are now of considerable market value for the economic products they yield. Persistent fishing has reduced seriously the numbers of sturgeon in St. John river, New Brunswick, and in Lake-of-the-Woods, Ontario, where at one time, twenty years ago, they abounded and caviare was prepared and shipped in great quantity. The Pacific species, the gigantic *Acipenser transmontanus*, Mitchill, once common in the Fraser river, B.C., and reaching a weight of a thousand pounds or more, is now scarce, and the widely spread fresh-water species *Acipenser rubicundus*, Le Sueur, has been also greatly reduced in numbers. It does not migrate to and from the sea like *A. sturio* of the Atlantic and European rivers.

9. *Game Fish in Canadian Waters.*—The rivers, lakes, and shores of Canada have been often described as constituting the angler's paradise, and it may well be doubted if any salmon rivers surpass in scenic grandeur and in surpassing facilities for sport the forty or fifty salmon rivers which pour into the Gulf of St. Lawrence from Cape Breton to Labrador. The Restigouche river has been ranked as the world's finest salmon river. The brook trout and sea trout of streams in eastern Canada are really chars (*Salvelinus*); but they are dainty and gamesome fish for the angler. Some of the Pacific trouts,

FIG. 31. CANADA'S PREMIER SALMON STREAM
The Restigouche River, Baie des Chaleurs.

such as the rainbow and the cut-throat, rank high for fighting qualities when hooked. The striped bass of the Atlantic coast is a noble game fish, the tunny or so-called giant horse mackerel, in weight from five to nine hundred pounds, and the mighty sword fish, weighing often four hundred pounds, are pursued by sportsmen along the shores of the maritime provinces. Special gear and modes of capture must be adopted to secure these powerful monsters. The black bass of the Canadian lakes and rivers takes a high place for boldness and for tireless strength. There is hardly a finer form of sport than fly-fishing for the small-mouth black bass, but its near relative, the large-mouth black bass, is also a good game fish.

The waters of Canada for their variety and extent, for their purity and coldness, and for the beauty of their scenery, challenge those of any other country. It is no surprise, therefore, to find that the finny tribes which inhabit them, both marine and fresh-water, provide, owing to their abundance and excellence, almost unsurpassed commercial fishing industries, and that the game species furnish recreation and sport which it is no exaggeration to claim are peerless.

OCEANOGRAPHY

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During the nineteenth century sporadic investigations of Canadian waters were made, chiefly by the naturalists of Canada and of the United States. Toward the opening of the present century oceanic investigation received a considerable impetus by the formation under the Minister of Marine and Fisheries of a marine Biological Board, which has become the Biological Board of Canada. It administers a grant, which is used for the investigation of the sea and inland waters in connexion with the fisheries. It maintains two stations, one on the Atlantic at St. Andrews, New Brunswick, and the other on the Pacific near Nanaimo, B.C., which serve as centres for investigations on the two coasts, carried on almost wholly by workers from the Canadian universities. The tides and major currents are investigated by a branch of the Department of Marine and Fisheries under the direction of Dr. W. Bell Dawson. In 1915 a hydrographic (temperature and salinity) and planktonic survey of the Canadian Atlantic waters was carried out under the direction of Dr. J. Hjort of Norway, and this has laid the foundation for an interpretation of the varied and complex conditions existing in those waters. In 1921 there was formed an International Committee on Deep Sea Fisheries Investigations, which now has representatives from Canada, the United States, Newfoundland, and France. Its function is the correlation of investigations in waters, in which these countries have a more or less common interest.

Canada's sea-coast is not continuous, being interrupted by Alaska at the northwest and Labrador on the east, which divide it into three portions—Pacific, Arctic, and Atlantic. Of the water along the two former we will give but brief accounts, but will concentrate on the Atlantic region, the one to which investigators have so far given most attention, and which is of such great importance for navigation and for the deep-sea fisheries.

The Pacific coast of Canada extends through over six degrees of latitude, but exhibits comparatively slight changes in conditions from north to south. Its waters are but little known and afford a most interesting field for study in the varied nature of its fauna and flora, and in the peculiarities of its physical features. The landward trend

of water from the open Pacific, reinforced to an undetermined extent by upwelling from the depths, furnishes the outer coast with a water of high salinity and equable temperature. In this flourish a fauna and a flora almost tropic in character and of extraordinary variety. This is well shown by the crabs, which are to be found in great numbers and variety. We may instance the bizarre family Lithodidae, which is represented by nine genera—*Hapalogaster*, *Oedignathus*, *Acantholithodes*, *Placetron*, *Phyllolithodes*, *Cryptolithodes*, *Lopholithodes*, *Rhinolithodes*, and *Leptolithodes*.

Inside the outer fringe of islands there is a network of channels and inlets with comparatively deep water, in large part of the nature of barrier fiords. While the conditions and life of the outer coast extend more or less thoroughly into this inland water, there is also to be found an assemblage of almost arctic forms, living for the most part at some distance below the surface. We may instance the capelin, almost restricted to the Arctic region in Europe, but here found as far south as Nanaimo in the same latitude as Paris; also the arctic crab *Chionoecoetes opilio*, the arctic shrimp *Nectocrangon lar* (or *dentatus*), and the arctic spiny ascidian *Boltenia echinata*.

The Arctic coast from Alaska eastward has recently been studied and explored by the Canadian Arctic Expedition of 1913 to 1918 under V. Stefansson, the reports of which are now appearing. Although the fauna is distinctly of a high arctic character, the warm conditions that extend up the Pacific coast and through Bering sea to a certain degree modify the temperature, permitting the herring, which cannot be considered an arctic form, to succeed as far east as Bathurst inlet.

Boothia peninsula and Baffin land, being separated only by the narrow Fury and Hecla straits, form a rather effective barrier between the western part of the northern coast of the continent and the eastern part which may be called the Hudson Bay region. Hudson bay, although known from the earliest days and traversed regularly by vessels in more recent times, is still largely unexplored, and we possess only the most fragmentary knowledge of its oceanography. The general circulation of the water is contra-clockwise, passing south along the west coast and north along the east coast. Salt water enters it from Fox channel and Hudson strait, bearing ice and sometimes icebergs. Although it never freezes over, the temperature of the main mass of the water is always close to 0° C. (32° F.), mostly below that point, and the surface water attains a maximum temperature of about 5° C. (41° F.). Higher temperatures (7°-12° C.; 45°-53° F.) are attained at the southern end, near and in James bay, but this water is of quite low salinity (20 to 25 per mille.), owing to the large quantity of water poured in from the rivers that drain a large part of the prairie

land of the Canadian west. This comparatively warm and brackish water passes north along the east coast in the outflowing current. So far as has been ascertained the waters of Hudson bay support a somewhat meagre Arctic fauna. The outflow from the bay passes eastward along the south side of Hudson strait, at a temperature never as high as 40° F., to join, at the mouth of that strait, the water coming south from Davis strait and Baffin bay. Together these form the Labrador current, which during the winter and spring transports immense quantities of icebergs and field ice to the Newfoundland region.

A striking feature of the northern part of the Atlantic coast of America is the submerged side of the continent, forming a shelf one hundred miles or more in width culminating off Newfoundland in the Grand bank with an area of about 40,000 square miles (Fig. 32). From this bank the steep side of the continent trends, as does the coastline itself, on the one hand northward and northwestward, and on the other hand westward and southwestward. The outer part of the shelf shows a series of elevations, which forms the important fishing banks from Cape Cod northwards, of George's, Brown's, La Have, Sable island, Banquereau, St. Pierre, Green, and Grand banks. These are covered with less than fifty fathoms of water. Inside the banks are basins (Figs. 33, 34) with depths of one hundred fathoms or more, connected with the open ocean by channels which traverse the shelf between the banks. The most important and deepest of these is the Laurentian channel, the former bed of the St. Lawrence river, from the mouth of which it extends across the gulf to and through Cabot strait, finally dividing Banquereau and St. Pierre banks before debouching on the side of the continent.

In the open Atlantic the *tropic* or "Gulf Stream" water (see Fig. 36), with a temperature of about 15° C. and a salinity over 35 per mille., presses constantly northward. The shape of the Atlantic basin and the rotation of the earth give it a pronounced eastward tendency toward the coast of Europe. The prevailing westerly winds heighten this tendency at the surface and create the illusion of a stream in mid-ocean. Beneath the tropic water, which has a thickness of several hundred fathoms, diminishing from south to north and from east to west, a heavier bottom water moves slowly toward the equator. It has a temperature of about 4° C. and a salinity of from 34 to 35 per mille. It is the tropic water which has been altered to a boreal condition by sojourn in the north, and is now known as the *bottom* or *slope* water. It is returning toward the equator, and as a result of deflection by the rotation of the earth, it is massed against the American side.

The outstanding geographic feature of the American side of the North Atlantic is the submarine promontory that forms the Grand

FIG. 32. CIRCULATION OF THE WATER

bank and Flemish cap. The southward-flowing arctic water of the Labrador current continues down the east coast of Newfoundland, changing somewhat in character through mixture with offshore oceanic water as it goes. The main part attempts to round the Grand bank, but at the southern tip it comes into contact with the northward-flowing current of tropical water. The two mix rather readily and the ice of the arctic water rapidly melts. The resulting mixture is heavier than either of the constituents, and sinks to join the deep mass of cool water moving toward the equator. This cabbeling process draws in more water and keeps up a movement of both arctic and tropic water toward the sinking point.

A certain amount of the arctic water, more or less mixed with the tropic water, rounds the tip of the Grand bank and moves westward and southwestward along the side of the continent. It is joined by water from the continental shelf, and it mixes with the tropic water along an extended front, passing southwest almost parallel to the edge of the continent, but approaching the latter towards the southwest. Cabbeling takes place along the whole of this front, giving a distinct vertical line of demarkation between these two bodies of water (Fig. 33), to which the names of "Gulf Stream" and "Cold Wall" are usually given. The dividing line shifts with the season, moving offshore in winter and onshore in summer.

A small branch of the arctic current hugs the coast of Newfoundland and rounds Cape Race to pass westward along the south coast. This movement does not progress far, being impeded and turned oceanwards by the barrier formed by the Burin peninsula, the Miquelon islands, and St. Pierre bank.

A smaller branch of the arctic current enters the Gulf of St. Lawrence (but not as a steady stream) through the Strait of Belle Isle on its north side, and mixes with the waters of the gulf, spreading its influence chiefly along the north shore, and carrying icebergs occasionally as far as Anticosti island.

It has recently been found that the coastal waters inside the continental shelf are in slow circulation (see Fig. 32) at rates ranging for the most part from two to six miles a day. The course of the horizontal circulation is determined largely by the configuration of the bottom, the water rotating in a contra-clockwise direction around basins, and in a clockwise direction around islands and shoals. The most rapid rates exist near the surface along the margins of deep basins or channels, even when these margins are five hundred feet or more from the surface, as is the case for much of the Laurentian channel. The most constant motive power for this circulation is the pumping action of the tides, the rotation of the earth acting as an imperfect valve in diverting the

ebb and the flood toward opposite sides of the channels and basins. This is well shown by the Strait of Belle Isle, through which, during the summer, arctic water is pumped into the gulf on the north side, and warm gulf water pumped out into the Atlantic on the south side. To the tidal effect are added the more irregular or varying movements, due to wind, differences in barometric pressure, and differences in density due to local heating or admixture with fresh water. These differences in density effect a considerable vertical circulation, outwards at the surface and inwards towards the heads of the bays and estuaries below (see Fig. 33). The tides are also effective in this direction, a striking example occurring at the head of the deep Laurentian channel below the mouth of the Saguenay river. During flood tide, when the warm, brackish surface waters generally are moving inwards, a surface current of cold, salt water forced up from the depths flows outwards along the south shore for a number of miles (Red island to Bic island).

The chief movements of the coastal waters are in a series of gigantic eddies, corresponding to the deep basins, for example, the Maine eddy around the deep basin of the Gulf of Maine, and the Laurentian eddy around the deep Laurentian channel and basin.

The salt water that invades the continental shelf is from two sources, the arctic current at the north, and the "cold wall" offshore. The arctic current contributes water to the Laurentian eddy through Belle Isle strait, and dominates the Newfoundland eddy, which lies between the Grand and St. Pierre banks. The "cold wall" furnishes the bottom water for the larger, deeper eddies. In each eddy the coastal water from the north and the "cold wall" water from off shore are mixed together and with the fresh water of the rivers, and the mixture spills over more or less regularly into the next eddy to the south and west, and superficially across the cold wall oceanwards.

Great contrasts in conditions are presented, not only offshore, but also on the continental shelf, where the salinities are considerably reduced, the average being about 32 per mille. as compared with about 35 per mille. in the open ocean. In the early part of the nineteenth century Bayfield and Kelley discovered the presence in the Gulf of St. Lawrence of an ice-cold middle layer between a deep layer and a surface layer, both comparatively warm (see Fig. 33). This condition prevails over the deeper parts of the continental shelf almost as far south as the Gulf of Maine. The deep water is from the "cold wall" and is therefore *slope water*. It has a salinity of 34 per mille., and a temperature approximating 5° C. (41° F.). The middle layer or *bank water* is formed more or less locally by the melting of the winter's ice, or comes from the arctic current. It has a salinity of approximately 32 per mille., and a temperature almost always below 0° C. (32° F.),

sometimes as low as −1.8° C. The surface or *coastal water* varies greatly with the seasons, but in many places, during summer, it attains a temperature of 15° C. (59° F.) or over, as a result of the direct action of the sun's rays and the influx of warm river water. It is of very mixed origin and its salinity is extremely variable, 30 per mille. being a fair average.

The half-open character of the Gulf of Maine and the funnel shape of the Bay of Fundy favour the development of heavy tides, which attain an amplitude of more than fifty feet at the head of the Bay of Fundy, and produce the tidal bore that rushes up the Petitcodiac

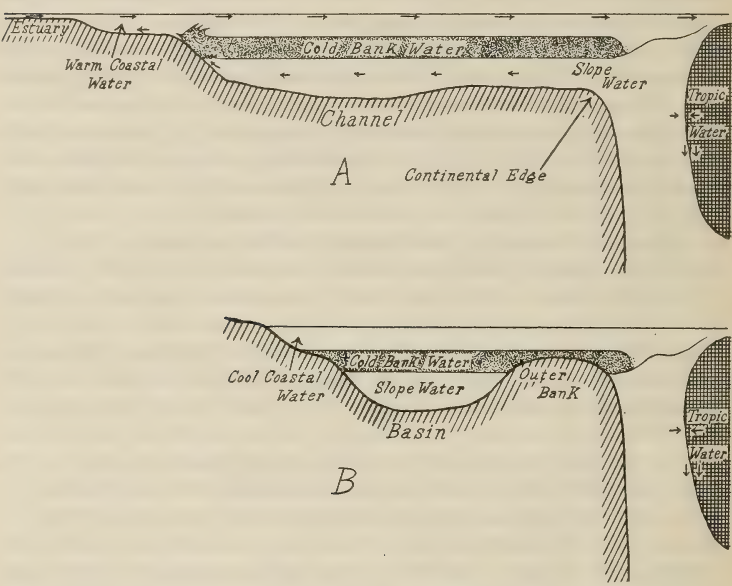

FIG. 33. SECTIONS AT RIGHT ANGLES TO COAST
A, along a channel; B, across an outer fishing bank.

river to Moncton. At St. John the exit of the chief river of New Brunswick is through a narrow gorge, which prevents the reservoir of reaches and lakes connected with the river from filling and emptying with the rise and fall of the tide in the Bay of Fundy outside. This gives rise to a reversing falls, pouring inward at high tide and outward at low tide. The strong tidal currents flowing over the shoals and through the narrow passages of the archipelago on the west side of the mouth of the Bay of Fundy mix the water so thoroughly as to

prevent largely the development of the stratification so characteristic of northern waters, whose upper layers undergo such extreme changes in temperature, and therefore in density, during the year. The intermediate cold layer is scarcely and rarely recognisable. At the same time the surface water is kept so cool, even at the height of summer, that conditions approximating those in the far north are produced in the shallow water.

In the Gulf of St. Lawrence the restricted nature of the connexions with the ocean hold back the tidal development, so that, particularly in the shallow southern part (Magdalen shallows), the tidal amplitude is slight and the currents weak. Near the Magdalen islands at the centre of the gulf the tidal range is reduced to three feet or less. As the amount of mixing is consequently slight, the surface waters are given an opportunity to reach a comparatively high temperature during the summer (see Fig. 36).

The prevalent westerly winds drive the heated upper layers of the main portion of the gulf against the Newfoundland coast, giving warm conditions in the bays there and accumulating a mass of warm water at the inner end of Belle Isle strait. Part of this mass passes out through the strait on the south side and part swings across to the north shore of the gulf to temper the effect of the incoming arctic water, and to produce at times comparatively warm conditions in the bays of the eastern part of that shore.

The westerly winds are similarly effective in concentrating the heated surface water of the Bay of Fundy towards its head, particularly in Minas basin, giving suitable living conditions for a number of southern animals.

From the account just given it will be seen how complex and varied are the physical conditions of the waters along the Canadian Atlantic coast. Corresponding with these, the life in the waters is of extremely varied character and distributed in an interesting fashion paralleling the physical conditions.

The fundamental factors for determining the character of the life in the water and for limiting its distribution are the physical conditions. Within the limits they set, the biological factors, such as food relationship between forms, are able to operate. Only a few of the physical conditions are sufficiently varied or are sufficiently known for the region we are considering to be treated here.

The rapid stoppage of the sun's rays by the upper layers of the water furnishes ample room at all depths more than a few fathoms from the surface for a host of dark or twilight animals that cannot survive the full glare of the sun. These remain constantly in the deeper water, or else come near the surface at night or in places more

or less thoroughly protected from direct sunlight, as beneath stones and ledges. Many of these are able at some stages in their life histories to endure strong light and may, therefore, occur for a time in shallow water or near the surface.

For bottom forms the nature of the substratum is of great importance. Soft bottoms of mud or muddy sand provide suitable burrowing material and a superficial layer of organic debris of considerable nutritive value. Hard bottoms of stones or rocks give shelter and surface for attachment free from silt, and usually also a favourable position in the currents for obtaining food from the floating life. Sand and gravel that are more or less constantly moved by wave action offer suitable conditions for few animals (chiefly burrowing forms) and are quite barren of life.

The great variations in salinity that exist, particularly in long estuaries, present very effective barriers to the spread of many forms of life, and sort out the species in an interesting way. Some that are killed by low salinities are able to spread or survive in being carried from the open ocean far inwards over the continental shelf and up the estuaries in the highly saline water that flows inwards near the bottom of the deep channels. If their habits cause them to rise from this deep salt water, they rapidly perish and spread but a short distance. If the eggs or larvae pass naturally into the upper layers and are unable to withstand the low salinity, they perish and the species is maintained in the bottom water of these channels only by immigration.

On the other hand the species that are unable to endure high salinity may spread, or be carried from the estuaries, for a longer or shorter distance into the salt water or oceanwards in the less salt upper layers, ultimately perishing.

Temperature plays a most important rôle in limiting our oceanic life, although the range off the Canadian Atlantic coast is only 22° C., from about −2° C. to 20° C. Cold-water forms come south in the Labrador current from the arctic seas and perish when the temperature rises from mixture with the tropic water or from the heating effects of summer. Warm-water forms move northward in the tropic water and survive for a longer or shorter period on passing into the colder water toward land or toward the northeast. On the continental shelf the seasonal changes are more pronounced and the circulatory movements slower. Cold-water forms are able to extend inshore and far southward along the coast during the winter season, but perish when the heat of summer comes, unless they reach cold enough water in the deeper layers. Warm-water forms pass rather far northward in the outer parts of the eddies during the summer, but perish in the winter season, unless able to return to warmer water. Cold-water

forms that can pass through their life cycles without coming near the surface unless during the winter season, and those that require or can endure warm water in the stage passed near the surface, are endemic in the colder deep layers, while the others continue merely as immigrants. Similarly, warm-water forms that are able to endure the winters' cold are endemic on those parts of the coast where the summer temperature is high enough for their growth and reproduction.

As a consequence of the earth's rotation, movement of water from the equator affects, in the North Atlantic ocean, the European coast more than it does the American, and movement of water from the pole affects the American coast more than it does the European. The tropic water has both higher salinity and higher temperature than has the arctic, and as a result the water of the European coast is both warmer and salter than that of the American coast. The waters of the continental shelf from Cape Cod to Newfoundland have no very close counterpart on the European coast. In temperature they somewhat approximate those of the Scottish and Norwegian coasts, but in salinity they are very dissimilar. This region roughly corresponds with the Canadian coast, and is of the greatest importance commercially because of the productivity of the very extensive fishing banks.

The dominant forms of the region would be classed as boreal, and the majority of them occur south of Cape Cod only as winter migrants, and north of Newfoundland only as summer migrants or as isolated colonies in sheltered bays. Some of the commoner forms are the cod, haddock, herring, gunnel (*Pholis gunnellus*), lump-fish, common shrimp, lobster, the copepod *Calanus finmarchicus*, soft clam (*Mya*), razor clam, mussel (*Mytilus*), shore snail (*Littorina litorea*), common whelk (*Buccinum undatum*), dog whelk (*Purpura*), common starfish (*Asterias vulgaris*), sun star, blood star, basket star, *Pentactes frondosa*, northern sea-urchin (*Strongylocentrotus*), *Cyanea arctica*, *Aurelia flavidula*, and the algae *Laminaria digitata*, *Agarum turneri*, *Ascophyllum nodosum*, *Fucus vesiculosus*, *Ptilota serrata*, and *Chrondus crispus*. Even these dominant forms are more or less limited by temperature as well as by other factors within the limits of the region. Nowhere does the lobster find conditions too warm for any stage in its life history. The low winter temperatures are such as seem to be required in the egg stage and the adult thrives along the whole coast. The fry, however, require comparatively high temperatures, and perish except in the warm water of sheltered bays and on the Magdalen shallows. The Greenland sculpin gets suitable breeding conditions during the winter and finds most of the shore waters suitable even at the height of summer; but it is largely or wholly eliminated from the Magdalen shallows and the bays where the water warms to a temperature exceeding 15° C. The

flatfish *Hippoglossoidés platessoides*, though able to live as an adult in the bank water all along the coast at temperatures from 10° C. down to as much as −1° C., has eggs that float near the surface and survive only in the warmer of the surface waters (over 10° C.).

The most striking invasion of the region is by arctic forms. The arctic current, with its Hudson Bay component, rich in the leachings of the western prairies, reaches the Newfoundland region in a relatively barren condition. It fails to show the wealth of pelagic crustacea and fishes that characterises boreal waters. The more limited of the ultimate food stuffs are largely locked up in the countless jellyfishes (chiefly *Mertensia* and *Beroe*) with which the water teems. This food is not available until these jellyfishes perish with the rising temperature resulting from mixture with warmer water. This takes place over a wide front during a very considerable part of the year and makes possible a steady supply of diatoms and other minute plants to start the food cycle that produces the unexampled richness in fish and other animal life of the fishing banks over and near which the mixing occurs.

The arctic current has a salinity from 30 per mille. to 34 per mille., and a temperature for the most part near or below 0° C., except that the surface warms to about 6° C. during the summer. In it live a considerable number of forms that fail to survive in the warmer waters to the south, such as the polar cod, the spiny lumpfish, the amphipod *Euthemisto libellula*, the pteropod *Limacina helicina*, the ctenophore *Mertensia ovum*, and the medusa *Aeginopsis laurentii*. Other arctic forms find suitable conditions in the ice-cold bank water (see Fig. 34), or endure for a time the higher temperatures to which they are exposed. Such are the capelin, the Greenland shark, the Greenland cod, *Icelus bicornis*, *Gymnocanthus tricuspis*, *Stichaeus punctatus*, *Chionoecoetes opilio*, *Nectocrangon dentatus*, *Acanthostepheia malmgreni*, *Synidotea nodulosa*, *Lamprops fusca*, *Chelyosoma macleayanum*, *Portlandia arctica*, *Cardium groenlandicum*, *Pandora glacialis*, *Buccinum glacialis*, *Hypothyris psittacea*, *Myriotrochus rinkii*, *Asterias polaris*, and *Stegophiura nodosa*. Several mammals belong to this category. The white whale or beluga is a regular inhabitant of the lower St. Lawrence, and an occasional individual may be observed every few years as far south as the Bay of Fundy. The harp seal and the hooded seal still occur in rather large numbers every year throughout the Gulf of St. Lawrence and on the outer banks as far south as Sable island. Formerly the walrus had a similarly extensive range. Although not permitted to survive short of northern Labrador at the present day, scattered individuals almost regularly come south on the icefloes to the eastern coast of Newfoundland and the northeastern part of the Gulf of St. Lawrence. Similarly, the polar bear still reaches both coasts of northern

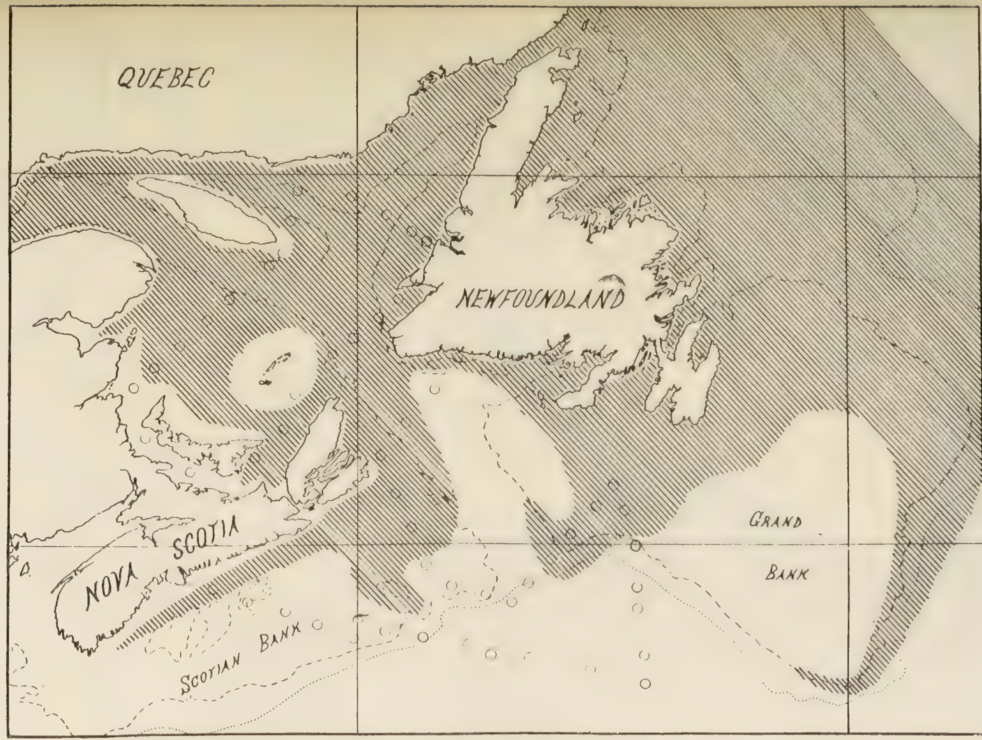

FIG. 34. DISTRIBUTION OF THE ICE-COLD BANK WATER IN EARLY SUMMER

Newfoundland, and undoubtedly occurred as far south as Nova Scotia in early historic times. The Eskimo, also requiring arctic conditions, was an inhabitant of the north shore of the gulf when Europeans came, and is not yet extinct in northern Newfoundland.

The slope water in its ramifications over the continental shelf (see Fig. 35) permits the extension coastwards of many forms that seem to require a high salinity and a constant rather low temperature. Planktonic or pelagic forms include the rosefish (*Sebastes marinus*), *Pasiphaea multidentata*, *Meganyctiphanes norvegica*, *Scolecithrix minor*, *Metridia lucens*, *Conchoecia borealis*, *elegans* and *obtusata*, *Eukrohnia hamata*, *Sagitta maxima*, *Diphyes arctica*, and *Periphylla hyacinthina*. Some of these are endemic in the deeper parts of the shelf, some survive as adults but fail in breeding, and others are carried a variable distance before perishing. Of bottom forms may be mentioned the grenadier (*Macrurus bairdii*), the four-bearded rockling (*Enchelyopus cimbrius*), *Munidopsis curvirostra*, *Calocaris macandreae*, *Pontophilus norvegicus*, *Epimeria loricata*, *Munnopsis typica*, *Portlandia lucida*, *Dacrydium vitreum*, *Ophioscolex glacialis*, *Schizaster fragilis*, *Virgularia ljungmanni*, and *Pennatula aculeata*. The heavy tides of the Bay of Fundy bring some of these forms into quite shallow water in the western archipelago, and here *Macrurus*, *Meganyctiphanes*, and *Munnopsis* occur even at the surface. For such forms the exposure to sunlight and lowered salinity may be fatal. As an instance of the complex conditions involved, the rockling may be mentioned. In the Gulf of St. Lawrence the adults live in the depths of the Laurentian channel, while the eggs float up through the ice-cold bank water into the warm surface water, where development is successful. The fry and the young (known as mackerel midges) remain at the surface. In the Bay of Fundy the adults occur from deep water well inland in the rather shallow waters of Passamaquoddy bay. The eggs perish in the cool surface water, and the population is kept up by the immigration of mackerel midges from the Gulf of Maine.

In the tropic water outside the continental shelf (see Fig. 36) may. be found a great wealth of warm-water planktonic or pelagic species The sargasso weed (*Sargassum bacciferum*) shelters or offers lodging for such species as the crab *Planes minutus*, the prawn *Latreutes ensiferus*, the amphipod *Sunamphithoe pelagica*, the isopod *Idothea metallica*, and the hydroids *Obelia hyalina*, *Clytia noliformis*, *Plumularia setaceoides*, and *Sertularia cornicina*. Individuals of the tropic water are not numerous, but of species there are many, of which we may mention a few—the sunfish (*Mola*), the flying fish (*Exocoetus volitans*), the blue shark (*Prionace*), the sea horse (*Hippocampus*), the king fish (*Lampris luna*), the pilot fish (*Naucrates ductor*), the sword fish (*Xiphias

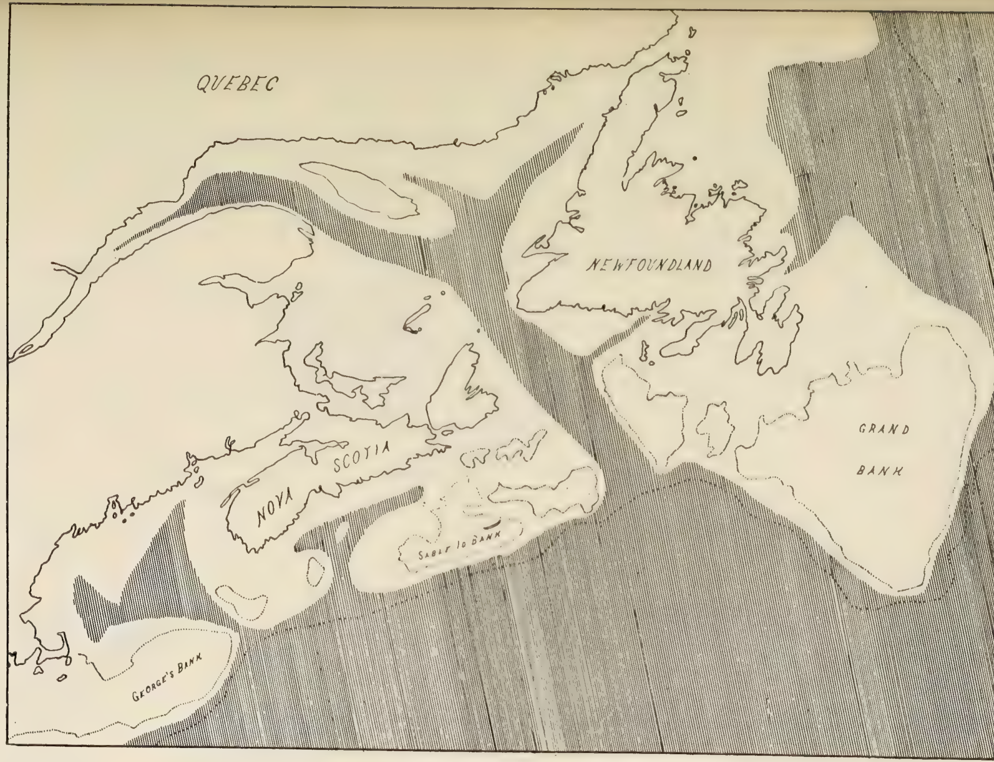

FIG. 35. DISTRIBUTION OF SLOPE WATER OVER THE BOTTOM

gladius, for which there is a considerable coastal fishery); amphipods of the genera *Phronima*, *Phronimella*, *Euprimno*, and *Phrosina*; various species of *Salpa*, *Doliolum;* the chaetognaths *Sagitta enflata* and *Pterosagitta draco;* copepods of the genera *Rhincalanus*, *Clausocalanus*, *Candacia*, and *Pontellina:* the Portuguese man-of-war, and the medusae *Rhopalonema velatum*, and *Bassia bassensis*. The tropic water has no inshore extensions, and only near the Grand bank, do mixing whorls regularly occur to carry the tropic species into the more superficial slope-water and thence to the waters on the continental shelf. Nevertheless at times, particularly in late summer, when the northward movement is at its maximum, many species not only actively migrate, but also are passively carried to the coast and in the case of the more resistant forms far into the gulfs and bays. It would seem that this invasion is greatest near the Grand bank, as the little collecting done has shown that certain tropic species are more abundant on the coast near that region than farther westward.

The warmer parts of the coastal water (see Fig. 36), in particular the Magdalen shallows, make possible the survival of colonies of species whose proper home is farther to the south. They have been considered as relicts of a former more general distribution of warm-water forms northwards. These species in various ways show the unfavorable conditions with which they have to contend. They may be rare, and of very local occurrence, or they may increase in numbers only during particularly warm seasons. As examples of these more southern forms we may mention the following—cunner (*Tautogolabrus*), pipefish (*Syngnathus*), sand flounder (*Lophopsetta*), *Palaemonetes vulgaris*, *Haustorius arenarius*, *Gammarus annulatus*, *Leptochelia rapax*, *Oxyurostylis smithii*, *Balanus improvisus*, the oyster, the quahaug (*Venus mercenaria*), *Petricola pholadiformis*, *Teredo navalis*, *Crepidula fornicata*, *Urosalpinx cinerea*, *Bugula turrita*, *Eutima formosa*, and *Calyptospadix caerulea*. As examples of the very local occurrence of certain of these warm-water species we give the following cases. For Canadian waters *Loligo pealei* is known only from the Bay of Fundy, at the head of which it breeds; *Libinia emarginata* and *Ovalipes ocellatus* only from Minas basin at the head of that bay; *Callinectes sapidus* only from Cow bay near Halifax; *Neopanopeus sayi* only from Richmond bay, Prince Edward island; and *Rhithropanopeus harrisi* only from the Miramichi river, northern New Brunswick. With the exception of the first, a squid, these are all crabs.

The complex circulation of the waters of the region commingle deep-water species with shallow-water species, arctic with tropic, and oceanic with coastal or even fresh-water species in most bewildering fashion; but the heterogeneity does not last, for the individuals out of

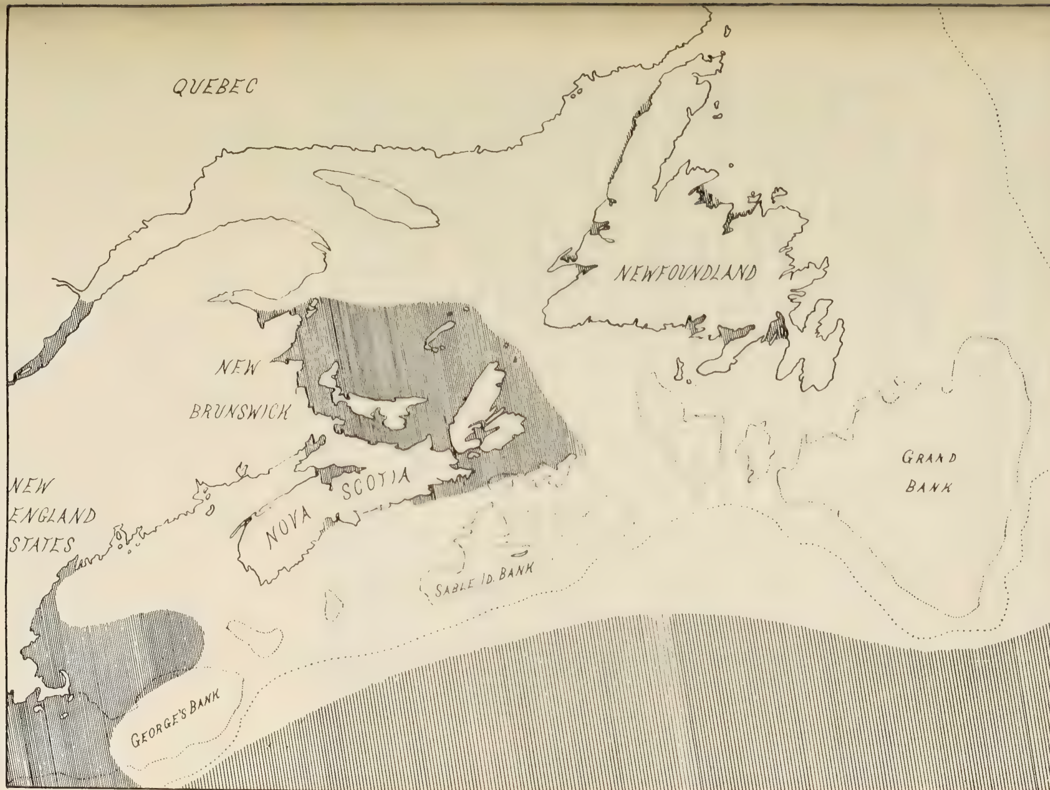

FIG. 36. DISTRIBUTION OF THE WARM COASTAL WATER (INSHORE) AND OF THE TROPIC WATER (OFFSHORE)

place soon perish, and the normal facies of the life for each set of conditions is restored. These continuous acclimation experiments on a tremendous scale give no evidence of success. The capelin may succeed for a year or two under exceptional conditions in colonising the Bay of Fundy or northern Labrador, but the return of normal years forces it back within the bounds which its nature and the physical conditions set.

The limiting forces act in many ways. With the high tides of the Bay of Fundy the sea-urchin (*Strongylocentrotus*) may creep up the intertidal zone with the neap tides and in cool weather, and on the sudden return of springing tides and warm weather be unable to retreat quickly enough to escape the destructive action of the heat. The smelt, obeying the spawning impulse, ascend the Magaguadavic river of southern New Brunswick, and meeting an impassable falls at the head of the tide, deposit their eggs in the intertidal zone. These eggs at times are bathed with the fresh river water which they require, but they are also flooded by salt water and exposed to the drying wind, and the scorching sun. Needless to say, they all perish. The common starfish settles from its larval life to the bottom in shallow water along the inner (western) coast of Cape Breton island. It thrives in this warm water, but as it grows larger it can no longer endure such high temperatures, and descends the steeply sloping bottom to a cooler zone. Here, however, it is successively exposed to the warm surface water driven down by an onshore wind, and to the ice-cold bank water brought up by an offshore wind, so it perishes. The chaetognath *Sagitta serratodentata*, from its home in the tropic water is carried into the superficial slope-water, where it attains a much greater size than is possible in its original habitat. This success is followed by the failure to leave any posterity, for, although the individuals mature, no young are produced.

THE FUR TRADE IN CANADA

Natural Resources Intelligence Service, Department of the Interior, Ottawa

For centuries before the white man came to America the Indians had trapped fur-bearing animals for raiment and food, and after the arrival of white traders fur was the chief commodity in commercial enterprise. In this trade the Indians were important factors; the haunts and habits of the fur-bearers were known to them and, matching their cunning with that of the wild fur-bearers, they trapped ample supplies. With the coming of the white explorers and traders these supplies of rich peltry were exchanged for trinkets of little value. The primitive need for the skins of wild fur-bearers established, also, those early methods of tanning and adornment, the first artisans of which were the women of the tribes. With tools of flint, bone, and iron and thread of sinews an Indian wife fashioned the clothes made from the skins of wild animals, adorning them with artistic taste by the aid of bits of fur and feathers. Thus she was alike tailoress, tanner, milliner, hatter, furrier, and decorator, the originator of arts and industries which, having their basis in the pelts of wild fur-bearers, are still the means of supplying the requirements of modern fashion and of furnishing employment for thousands.

The Beginning of the Fur Trade in Canada.—In the history of early exploration and commercial enterprise in Canada the fur trade was the paramount incentive, and the glamour of romance gives additional charm to every tale of heroic exploit performed by early explorers, adventurers, and nation builders for the control of the rich revenues from furs.

Organised commercial enterprise associated with French authority in Canada was centred at Tadoussac, founded by Chauvin in 1598. In 1599 he obtained with Sieur de Tontuit of Honfleur and Pont Gravé of St. Malo a monopoly of the fur trade. Their authority, though obtained by a promise to take out colonists, was mainly exercised in promoting trade in furs. This monopoly became void by the death of Chauvin and was next given to de Chastes, Governor of Dieppe, who formed a company and sent out ships. In 1603 Champlain visited Tadoussac and explored the Saguenay and heard for the first time of Lake St. John and of the "Salt Sea" (Hudson bay). He learned that

Indians from this direction came to Lake Nemiscau midway between Hudson bay and the St. Lawrence for the purpose of fur-trading.

When De Monts obtained a trading commission for one year from the French king in January, 1608, Tadoussac was still the important centre of the fur trade, and neither Three Rivers nor the Richelieu river were yet known to traders. By 1610 trading was alternately at Tadoussac and at the entrance of the Richelieu river. The vessels at this period carried usually from 12,000 to 15,000 skins yearly to France. After the founding of Quebec by Champlain in 1608 the de Caens, father and son, held a monopoly of trade and sent yearly to France from 15,000 to 20,000 pelts. From 1610 to 1618 Sault St. Louis was an important centre of the fur trade. For several years Three Rivers also held sway, as did Quebec and Isle de Richelieu above Quebec.

In the year 1627 the "Company of New France", known as "The Company of One Hundred Associates", was founded under Richelieu, its monopoly of the fur trade to extend from 1628 to 1643. Champlain was a member of this company, which had as directors distinguished and wealthy men of France. The country granted to this company included: "In all property, justice, and seignority, the fort and habitation of Quebec, together with the country of New France, or Canada, along the coasts . . . . . coasting along the sea to the Arctic Circle for latitude, and from the Island of Newfoundland for longitude, going to the west to Mer Douce (Lake Huron) and farther within the lands and along the rivers which passed through them and emptied in the river called St. Lawrence, etc." The company was constituted master of commerce in Canada and Acadia. It sent out from Dieppe four vessels under Roquemont which were destroyed by Kirke acting under letters patent from the King of England given to the Company of Adventurers, which authorized them to trade and to destroy the forts of New France. After the taking of Quebec in 1629 by Kirke and its subsequent restoration to France, Champlain was made governor and the French company again in 1633 sent out ships. The Island of Richelieu ten leagues above Quebec was fortified and made a fixed post for trading, the purpose being to combat competition. The value of beaver skins at that time may be gleaned from the claims of de Caen who alleged that Kirke had taken beaver skins to the number of 4,266, valued at £12 10s. each.

In one of his letters to France Champlain complained that Dutch, English, and Basque traders were constantly trading in the lower St. Lawrence. The French companies had done little for colonisation and the rivalry among fur traders was the cause of dissension. In 1645 another company, "The Habitants' Company", entered into competition in the trade. Events were shaping, however, which were

to change the existing conditions and have a lasting effect, not only on the fur trade, but on the whole future of Canada. "The Company of One Hundred Associates" surrendered its charter in 1663 and any exclusive privileges granted to other companies were soon discontinued and vested in the Crown of France. Along the St. Lawrence lay Montreal, Three Rivers, and Quebec, bound together by mutual interests and forming small but important points in the fur trade of New France. With the westward march of exploration and the fur trade new posts, widely scattered over the country south and west of Hudson bay, were established and matter for many new pages of stirring history was provided.

The fur trade had attracted by its lure of gold many fearless, independent spirits. Adventurers swarmed the courts of Europe and navigators had for years been seeking the northwest passage as a route to the east which had been considered England's greatest market, but as the East India Company had exclusive rights of trading in that quarter, it was but natural that the attention of Englishmen should turn to America. Tales of vast fortunes to be made from the fur trade there were accepted greedily by needy adventurers eager to turn their energies to this new field. What is now New York, New Jersey, and Delaware had been granted by the King of England to the Duke of York in 1664. The Dutch possessions in America had been taken from them and the New Amsterdam fur trade had come into the possession of the English. Hudson bay had been charted, a fact of importance in the light of future events.

Radisson and Groseilliers.—Among the fur traders of this period the names of Radisson and Groseilliers are especially distinguished as the discoverers of the Great West, and their later relations with the founders of the Hudson's Bay Company form an interesting chapter in the development of the fur trade in Canada. To Radisson and his brother-in-law, Groseilliers, is credited the establishment west of Duluth of the first trading post between the Missouri river and the Arctic Circle. They had travelled and traded over the country far and wide both in the service of the Company of One Hundred Associates and as independent traders. Their chief labour seems to have been the exploitation of the fur trade in the region of Lake Superior and Hudson bay. They were known as leading traders at Three Rivers in 1656, and had been the first to round Lake Superior. After a trading trip in the west around Wisconsin they came down to Montreal accompanied by 300 Indians and in possession of 60 fur-laden canoes. Unable to come to terms with the French authorities, and having been fined for illicit trading, they sought English alliances and in 1668 Groseilliers is credited with guiding the "Nonsuch", an English ship, to the mouth

of the Rupert river, named after Prince Rupert, where a fort was built, the first on the bay. The return of the "Nonsuch" to the Thames laden with fur was an attractive bait to the merchants of London.

Formation of the Hudson's Bay Company, and After.—The consequent formation of the Hudson's Bay Company in 1670 with Prince Rupert as the first governor was the opening of a fascinating story that was to embrace practically the whole of Canada. The charter given to "The Governor and Company of Adventurers of England trading into Hudson's Bay" granted control over all the regions whose waters emptied into Hudson bay. The first sale of the rich cargo of furs brought by the company's ships from this region was held at Garraways, London, in December, 1671, and brought together a distinguished gathering graced by the presence of the Prince of Wales and the Duke of York.

While these events were transpiring, the French had been energetic in their plans for extending the fur trade and their authority. They had invaded the Athabaska country as early as 1640, and claimed priority in the region of Hudson bay. There is a record of an expedition under Bourdon in 1657 to discover the Mer du Nord, thought to be Hudson bay. Talon had sent St. Lusson to take possession of Sault Ste. Marie, an important French post, and the surrounding region in 1671. At this time Michilimackinac, between Lakes Huron and Michigan, was a trading post of the French, and from here Cadillac was sent to found Detroit in 1701 for the purpose of forestalling Dutch and English traders who were diverting trade to Albany.

Radisson and Groseilliers, patriotic alone to the open sky and the fur market, quarrelled in turn with Quebec and Boston, Versailles and St. James, but ultimately Radisson became a stockholder in the Hudson's Bay Company and is last heard of as pensioned in 1710. Groseilliers died in Canada.

The company had established several forts on Hudson bay, but after the formation of a new French company in 1685 called the "Company of the North", De Troyes captured several of these.

Early in this conflict for supremacy between the English and French in Hudson bay there appears a lieutenant of De Troyes named Iberville, born in 1661, whose victories by land and sea entitle him to a place on Canada's roll of fame. With the re-taking of Fort Nelson in 1694 by the French under Iberville, Fort Albany remained the only post held by the British on Hudson bay. The English returned to the attack, re-taking Fort Nelson in 1696 and capturing a booty of 20,000 beaver skins, only to have the fort retaken by Iberville in 1697 in a famous sea fight. The treaty of Utrecht (1713) ended the strife; the Hudson Bay region was ceded to the British and the Hudson's

Bay Company again took possession of their forts on the bay. Though French traders still continued their trade for some years in this region owing to the dispute regarding the boundary, the directors of the company were able to treble their stock and pay enormous dividends in 1720. The operations of the company were extended and carried inland; in 1754 an important expedition sent out by Governor Isham crossed the country now known as the prairie provinces, journeying westward some 900 miles from York Factory to a point west of Red Deer. Laden with furs the expedition returned down the Saskatchewan river, pausing at Fort la Corne, founded by the French, and from there continued to its starting point on the bay.

After the fall of Quebec in 1759 independent traders grew numerous and rival companies were formed to contest the supremacy of the Hudson's Bay Company. A new phase in the fur trade thus opened. Among the rival British companies the most noted were the North-West Company and the X.Y. Company. The latter was formed because of a division in the stock holders of the original North-West Company, whose nucleus was a body of Scotch merchants, with head-quarters at Montreal. A famous leader of the North-West Company was Sir Alexander MacKenzie, who in 1789 left Fort Chipewyan on Lake Athabaska and by way of the MacKenzie river reached the Arctic. He later crossed the Rockies to the Pacific coast in 1792. Here the East India Company and the South Sea Company were already engaged in the fur trade to which the sea otter and fur seal were the chief contributors.

The organising genius of the American competitors was John Jacob Astor, a German Jew, who sailed for Baltimore in 1783 and engaged in the fur trade in New York as early as 1784. In 1810 with men formerly of the North-West Company he organised the Pacific Fur Company, and founded Astoria on the Columbia river in 1811. In 1813 Astoria came into the possession of the North-West Company, having been sold to them to prevent its capture by the British. In 1814, by the stipulations of the Treaty of Ghent which closed the war of 1812, Astoria was restored to the United States.

The bitter conflict between the North-West Company and the Hudson's Bay Company resulted in bloodshed at "Seven Oaks", near Fort Douglas, Red River district, where Robert Semple, who had been appointed governor-in-chief of the Northern Department of Rupert's Land by the Hudson's Bay Company, lost his life together with some twenty others. After the death of Lord Selkirk who had taken a prominent part in the affairs of the Hudson's Bay Company, the two warring companies united in 1821, the North-West Company transferring all its property and its partners becoming members of the

older organisation. This fusion of interests brought to the Hudson's Bay Company control of practically all the country lying west and north of Hudson bay not already included in its charter. Astoria, which had been re-named Fort George, was abandoned and Fort Vancouver established farther up the Columbia. When by the treaty of Oregon in 1846 the 49th parallel was made the boundary between the United States and Canada, the United States gained, while the Hudson's Bay Company and the British Empire lost, a great and rich area of country. The fur trade was one factor in the framing of the Oregon Treaty, the Statement of Claims of the United States showing that in 1811 the American establishment of Astoria was commenced near the mouth of the Columbia river before any British settlement had been made south of the 49th parallel.

Many years of prosperity for the Hudson's Bay Company followed after its fusion with the North-West Company. During this time it is said that as many as 150,000 Indians brought to its warehouses the product of their trapping efforts, for the handling of which at least 3,000 employees were maintained; but with the development of Canada the trading privileges of the Hudson's Bay Company were gradually curtailed. In the year 1870 it surrendered exclusive rights, receiving from the Crown in return certain grants of money and land. Competing companies have again entered the field and individual fur traders once again freely conduct their trading activities, subject only to such regulations as the federal and provincial governments have imposed.

Methods of Trading.—The fur traders came equipped for barter with standard articles such as mirrors, chisels, guns and gunpowder, blankets, buttons, beads, bells. Owing to the whimsical nature of the Indians it is recorded that Ingraham, a resourceful trader, introduced iron collars weighing seven pounds, made from half-inch rods which became extremely popular among the Indian belles of the west coast about 1792. The price paid was three prime sea otter skins worth £40 each on the Chinese market at the time; Radisson is credited with saying to a meeting of directors of the Hudson's Bay Company that different tribes had different longings and that an Iroquois preferred a brass nail to twenty yards of scarlet cloth, while the Eskimos desired knives, kettles, and hatchets.

The Fur-Bearers.—It is difficult to estimate the countless numbers of pelts which flowed from what is now known as Canada during the three hundred years of commerce in furs. Beaver, otter, fox of several varieties, lynx, fisher, mink, marten, badger, raccoon, muskrat, squirrel, contributed then as now. The sea otter and the beaver are notable examples of changed conditions. The former is now practically extinct, while the beaver occupies no longer its traditional prominence.

Beaver—For centuries the beaver was the fit emblem of the fur trade. Legends of Indian tribes give it superhuman powers; its pelt was used as a peace token and offerings of these, as "The Jesuit Relations" attest, alone made possible the building of many early churches. Beaver skins too were the currency of trade, and from the records of their barter we may appraise the volume and profits of early trading in furs. As early as 1650 the Tadoussac trade, which consisted chiefly of beaver skins, amounted to 40,000 livres profit and 100 canoes laden with these came yearly to this post. In 1660 Radisson, as we have seen,

FIG. 37. BEAVER CUTTING DOWN BLACK ASH AT NIGHT
Flashlight picture, courtesy of George Shiras, Washington, D.C.

arrived at Montreal from the west country accompanied by 300 Indians and 60 fur-laden canoes. In the year 1788 the trade of the North-West Company did not exceed $200,000; by 1799 or eleven years later the annual trade amounted to 185,000 pelts with a value of $600,000. Of these, 106,000 were beaver. The same number of skins in kind and quality would be worth $2,000,000 at present-day prices. Between the years 1860-70 the average number of beaver brought out was 150,000

skins to which must be added the numbers used by the Indians which represented an equal quantity. For the years 1853 to 1877 the Hudson's Bay Company sold in the neighbourhood of 3,000,000 skins in the London fur market. The beaver hat, during the 17th and 18th centuries, was worth 80 to 100 shillings and as an article of manufacture had an importance akin to that of the silk hat, its successor.

Sea Otter—The sea otter is the most valuable of fur-bearers and was once plentiful. It was a regal favourite and was taken in thousands on the Pacific coast between 1750 and 1875. Russian and Chinese royalty bought it and on the Chinese market the pelt sold at from $150 to $200. It was this fur-bearer that led to the first occupation of the Behring Sea islands and Alaska by Russia. The pelt of a prime sea otter measures six feet in length and is of rare beauty. While at Nootka sound Captain Cook is said to have bought 1,500 for sixpence apiece. Owing to the reckless killing of these animals they are practically extinct to-day.

Fur Seal—As late as 1847 the northern fur seal herds were estimated at 4,000,000 animals. Slaughter reduced their number to less than 200,000 by the year 1910. To save this valuable animal from extermination the Pelagic Sealing Treaty was entered into by Great Britain, the United States, Japan, and Russia. Under the terms of this treaty the killing of fur seals at sea is prohibited, except by the Indians or aborigines along the coast, using canoes, for the period of at least 15 years, during which time Canada is to receive 15 per cent. gross in number and in quality of the seal skins taken on the Russian and United States seal islands and 10 per cent. of those taken on the Japanese. Commercial killing was prohibited on the islands until 1918, but since then Canada has received her due revenue, the share for year 1922-23 amounting to $59,876. A steady increase is anticipated.

Marten, Muskrat, etc.—From 1821 to 1905 the Hudson's Bay Company collected 7,000,000 marten skins. Other companies in North America collected 2,600,000; from 1821 to 1891 the average catch was 119,000. From 1763 to 1800 the skins of the muskrat sold on the London market averaged not more than 75,000, but during the years 1801 to 1850 the average was about 410,000. From 1900 onward the yearly demand for this fur has ranged from 3,000,000 to 7,000,000 pelts.

Modern Commerce in Furs.—The fur trade of to-day has been affected to a marked degree by the advance of modern facilities for transportation. The extension of the railroad into the northern areas of Canada and the utilisation of the steamboat upon the larger rivers and lakes have been the means of bringing the pelt supply more rapidly to the markets of the world. The great and growing demand

for furs and the growth of the fur-dyeing industry in America with the many modern and successful experiments in fur-tinting have resulted in bringing into popularity some of the less costly furs, notably that of the muskrat. This humble but prolific fur-bearer of which Canada has an ample supply is now contributing millions to the value of the Canadian fur catch and at present is heading the revenue list in yearly catch. The total value of pelts taken in Canada in the season of 1921-22 was $17,438,867, to which muskrat contributed $4,707,043 as the value of 3,060,536 pelts, and beaver, $4,266,767 as the value of 232,134. Mink, marten, ermine, fisher, and fox were also in large supply.

Fur Production.—Despite three hundred years of exploitation, mostly for export to Europe, Canada still has within her possession one of the two greatest fur-producing areas, and with proper safeguards

FIG. 38. BALES OF FUR AT RAMPART HOUSE, YUKON TERRITORY

Fourteen thousand skins (bear, wolverine, etc.) ready for shipment to London.

may confidently expect to remain as a leading contributor to the world's fur supply. Every province contributes substantially to the returns derived from the fur resources, while the Northwest Territories, comprising an area of approximately 1,200,000 square miles, is a vast reservoir from which under wise methods of conservation a valuable and perpetual annual catch may be assured.

Fur Markets.—Before the entry of the British into the fur trade of Canada, the chief centres were Leipzig, Amsterdam, Paris, and Vienna. The monopoly held by the Hudson's Bay Company and the

commanding position it had won was such that the main current of the fur trade in America went to Great Britain; London became the leading fur market, and so continued until recent years.

The Great War wrought great changes in the fur trade, among which was the establishment of powerful competing fur centres in Canada and the United States. New York, St. Louis, and Montreal have become fur centres that attract buyers from all parts of the world. The fur auction at Montreal was inaugurated in 1920. Since its inception pelts to the number of 6,727,000 have been sold. These had a sale value of $17,567,000. The value of pelts disposed of during 1923 totalled $5,718,000.

Western Canada has also shown considerable enterprise, Winnipeg and Edmonton having established thriving fur auctions.

Exports from Canada have risen from $5,668,000 in 1914, to $16,385,000 in 1923, and imports from $3,755,000 to $7,246,000. Of the exports the United States took 69 per cent. and Great Britain 29 per cent. Of the imports the United States sent 80 per cent. and the United Kingdom 4 per cent.

Helpful Legislation.—In August, 1917, the Northwest Territories Game Act was amended and the administrative powers were placed under the Canadian National Parks Branch of the Department of the Interior, Ottawa. The administration has recently been transferred to the Northwest Territories and Yukon Branch of the Department of the Interior. Outstanding features of this Act are the provisions by which both trapping and fur-trading are put under the license system; the permission to Indians, Eskimos, and half-breeds who are *bona fide* inhabitants of the Northwest Territories to kill game when in actual need; the barring from the Northwest Territories of automatic rifles and shotguns; and the increase of the number of native hunting and trapping reserves.

A restricted area in the vicinity of Fort Smith, known as Wood Buffalo park, has been set aside by the Dominion government for the wild buffalo herd now ranging in that region. It is the largest national park in Canada, comprising 10,500 square miles, and is administered by the Northwest Territories and Yukon Branch of the Department of the Interior. With the creation of this park Canada can now ensure the protection and perpetuity of the only large herd of wild buffalo in the world.

Success has also attended the efforts of the Canadian government to preserve from extermination the buffalo of the plains. Some thirteen years ago Canada secured from a rancher in the United States the only large buffalo herd in North America, numbering approximately 700. This herd to-day numbers more than 7,000, with an expected increase

this year of 1,500 calves. A number will be marketed for the meat, hides, and wool; and the mounted heads, three of which brought $2,000 at the Montreal fur auction, will bring a rich return.

Extensive tracts of land have been withdrawn from settlement for the purposes of national parks which will aid greatly in the protecting of Canadian wild life. These preserves are provincial, as well as federal, and provision is being made for the opening of additional areas. Already somewhat more than forty thousand square miles have been reserved. Approximately they comprise:

LANDS RESERVED FOR NATIONAL OR PROVINCIAL PARKS

Alberta	8,000 square miles
Manitoba	5,000 " "
Quebec	5,000 " "
Ontario	4,500 " "
Saskatchewan	4,000 " "
British Columbia	4,000 " "
Northwest Territories	10,500 " "

Of the Canadian national parks the largest are Wood Buffalo park, 10,500 square miles, and Jasper park, 4,400 square miles, situated west of Edmonton. Some fifty provincial reserves have already been established; the largest are Laurentides park, Quebec, 3,700 square miles; Algonquin park, Ontario, 2,700 square miles; Cedar Lake reserve, Manitoba, 2,900 square miles; Pasquia reserve, Saskatchewan, 1,800 square miles; Clearwater and Smoky River reserves, British Columbia, 885 square miles. In addition there are numerous national bird reserves. Speaking of the important success of these parks in aiding wild life conservation Mr. J. B. Harkin, Commissioner of Canadian National Parks, says:—"In the parks to-day the casual visitor does not need to be told that wild life is abundant." There is a steady increase of wild life in all the parks and the natural overflow is re-stocking the adjacent areas.

Those who fight the battle for better forest protection are waging also a fight for the conservation of the wild life to which the forest is the great harbouring mother.

Fur Farming.—Supplementing the efforts of the federal and provincial governments in their enactment of laws for the conservation of wild life, the fur farmer in Canada has promoted the movement by his industry, the results of which have been most gratifying. There were 1,026 fur farms in Canada in 1922, comprising 977 fox farms, 17 raccoon, 13 mink, 3 skunk, 1 marten, 1 fisher, 4 karakul sheep, and 5 beaver. The total value of the fur farms comprising land and buildings and fur-bearing animals was $7,790,104. The number of fur-bearing animals on fur farms was 30,782, an increase of 7,000

over the previous year; of this number 22,318 were silver-black foxes. The number of live foxes exported for the year ending March 31, 1922, was 1,390, with a value of $310,709.

It is now 427 years since Cabot took furs to Henry VII, King of England. The modern cities of Quebec, Three Rivers, Montreal, Winnipeg, Calgary, Edmonton, and Victoria have tap-roots which were first fed by this still abundant natural resource.

FIG. 39. PRIZE PAIR OF CANADIAN SILVER FOXES

FIELD CROPS IN CANADA

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Of the chief agricultural countries of the world, for the three years previous to the war, Canada occupied third place in areas of farm crops, second place in areas of farm crops per capita, and first place in production per capita of food materials from farm crops. It is interesting to realise that, at the last period for which we have full statistics, Canada produced per unit of population more food materials obtained from farm crops than any of the other principal countries of the world. It is the amount of surplus over home consumption in the production of food materials which is the important factor in supplying the real necessities of life to those countries which are densely populated and which have to depend so largely upon other countries for their sustenance. Canada, therefore, holds a unique position, not only among the countries of the world, but particularly as an integral part of the British Empire.

The economic production of an abundant supply of food is probably the most fundamental material problem of the world. Increases in population demand corresponding increases in food supplies. Food production from farm crops can be increased by extending the acreage under cultivation, by the use of food-producing instead of non-food-producing crops, and by obtaining higher yields per acre. Of these three methods the latter is probably the most important at the present time.

Undoubtedly the yields per acre have been increased by the general use of good seed, by thorough cultivation, by endeavours to maintain or increase soil fertility, by increased drainage, and by the adoption of suitable systems of crop rotations. Marked improvements have been made in late years along most of these lines in some parts of Canada, but naturally greater attention will be given to these methods as the country becomes older and as the supply of labour increases. Canada is mostly divided into small farms and the rural dwellers own the land on which they live. There is, therefore, a great inducement for the individual farmers to make permanent improvements on their own homesteads. Nearly all of the people who are on rented farms or who hire with the farmers do so with the purpose of becoming land-

owners themselves when opportunities permit. The agricultural colleges and the experiment stations in the different provinces throughout Canada are doing much to help the individual farmers get started with the right kinds of seed and to use the most improved methods of cultivation.

Canada has become renowned, the world over, for her production of wheat of exceptionally high quality. She stands second in the amount of production and is now at the top of the list of all countries in the amount of wheat exported. In 1923 no less than 18,545,863 acres were devoted to the wheat crop in the Dominion and the total production is approaching a half billion bushels. It may be a surprise, however, to many people living in other countries to learn that the wheat occupies less than 36 per cent. of the farm crop acreages. One of the great advantages in this part of the empire is the fact that such a large number of farm crops can be grown successfully. Taking the five years from 1917 to 1921, the Canadian farm crops occupied the following relative areas, taking wheat as a basis: wheat, 100; oats, 81.8; hay and clover, 54.3; barley, 14.6; flax, 5.4; rye and mixed grains, each, 4.3; corn or maize, 4.2; potatoes, 4.0; buckwheat, 2.3; field roots, including mangels, swede turnips, etc., 1.5; field peas and alfalfa, each, 1.1.; field beans, .6; grain hay, .3; and sugar beets, .1. In addition to these crops, there are, of course, large areas used for pasture purposes. Some of the pastures are temporary and some are permanent. Numerous other crops are being grown in a limited way in certain sections or are being tested at some of the experiment stations. These include soy beans, hairy vetches, grass peas, horse beans, cow peas, burr clover, sorghums, sunflowers, sudan grass, millet, rape, silver beets, sweet clovers, etc.

The kinds of farm crops which are most extensively used in different parts of the country vary considerably owing to the particular kinds of farming which have been followed. In some parts of the western provinces, for instance, the number of varieties is much more limited than it is in the Province of Ontario, where about twenty different kinds of farm crops are grown regularly.

The livestock industry is increasing in importance as time advances and large quantities of the farm crops are consumed by the domestic animals and are thus converted into animals and animal products, many of which are exported in large quantities.

In 1905 the federal government passed the Seed Control Act which applied uniformly to all the provinces of the Dominion. This Act was revised from time to time and in 1923 a new law respecting the testing, inspecting, and sale of seeds was enacted on the thirteenth of June. "The Seeds Act, 1923" deals with both the purity and the

germination of practically all kinds of seeds of the different classes of farm crops which are grown throughout the Dominion. The Seed Branch of the Dominion Department of Agriculture administers not only the Seeds Act but also the Acts which deal with commercial fertilisers and with feed stuffs. These all have an important bearing on the production and the disposal of the field crops of the Dominion.

The results from the application of science to crop production in Canada is very marked. There are probably but few countries where plant-breeding has had a greater or a more far-reaching influence through the introduction of better varieties. The Dominion Experimental Farm at Ottawa was established in 1888 and since that time twenty-three other branch farms and stations have been started in different parts of the Dominion. These are all under federal control and are operated from the Central Experimental Farm at Ottawa. The Ontario Agricultural College at Guelph was established in 1874 and is located on a farm of over 700 acres. There are now schools or colleges of agriculture in practically all of the provinces of the Dominion, each having land for experimental and for demonstration purposes. Plant-breeding with farm crops has been an important feature of the work of the Central Experimental Farm at Ottawa and of the Ontario Agricultural College at Guelph for many years and the influence of this work is manifested in the crop production throughout Canada.

The greatest influence resulting from any one variety in Canada has originated through the creation and the distribution of the Marquis variety of spring wheat. This wheat originated through crossing the Hard Red Calcutta wheat from India and the Red Fife variety of spring wheat which had been grown in Canada for many years. The cross was made by Dr. A. P. Saunders and was selected, named, tested, and distributed by his brother, Dr. C. E. Saunders, formerly cerealist at the Central Experimental Farm, Ottawa. It is now stated that 80 per cent. of the wheat grown in Canada is of the Marquis variety and according to a report issued by the United States Department of Agriculture 16.2 per cent. of the acreage of all the wheat grown in the United States in 1919 was Marquis. Several other varieties of cereals have also been originated at the Central Experimental Farm through cross-fertilisation. Among these varieties might be mentioned Preston 4, which is grown considerably in some localities, there being over two million acres under cultivation in the United States; Prelude spring wheat, which is a very early variety and is now grown to a limited extent as far north as Dawson in the Yukon Territory; and Liberty No. 480, which is a hull-less oat and is giving better returns than any of the other varieties of hull-less oats that have been tested.

As the plant-breeding work at the Ontario Agricultural College at Guelph has been carried on more extensively and for a much greater length of time than at any of the other agricultural colleges, the references here made will be confined entirely to the work of that institution. Over 2,500 varieties of farm crops, obtained from different parts of the world, have been grown under test and their adaptabilities for Ontario conditions carefully studied. From some of the varieties of greatest merit, improved strains and varieties have been obtained through careful selections from large nurseries, planted by hand, with thousands of selected seeds. As a last resort, controlled cross-fertilisation has been used to originate new varieties superior to those obtained through selection from the varieties of highest record. For some time past an average of about 50,000 hybrid plants of farm crops have been grown and examined annually. The plant improvement work has included grain, forage, root, and tuber crops. The varieties of highest merit, obtainable by plant-breeding at the college, have been distributed to the farmers for co-operative experiments on their own farms. When they proved worthy under local conditions they were soon increased by the experimenters themselves at no additional cost for seed. The surplus is often sold to neighbours and to others to mutual advantage. Some of the most noted and the most influential varieties which have been originated at the college and are now grown over Ontario are O.A.C. No. 104 winter wheat, O.A.C. No. 21 barley, O.A.C. No. 72 oats and O.A.C. No. 181 field peas. Undoubtedly, the general use of the three former, high-yielding, new varieties of good quality has been the great factor in bringing about a decided increase in acre yields of the three principal grain crops of the province. From the accumulated data obtained by the Provincial Department of Agriculture within the past forty-two years, it is learned that the increases in the acre yields of barley, oats, and winter wheat for the last twenty-one years, in comparison with the former years, amounted to about two hundred and fifty million bushels, which, valued at average market prices, would reach a total of over one hundred and sixty-one million dollars. It might be interesting for some to know that this is over thirty times as much as the net expenditure of the Ontario Agricultural College during its entire history of a half century. It will be seen, therefore, that plant-breeding in this country is having a marked influence from the standpoint of utility.

Canada is a land of large dimensions, extending 3,500 miles from east to west and 1,400 miles from south to north. It is somewhat larger than the United States with Alaska included. The land area of the nine provinces of the Dominion, as a result of the Extension of Boundaries Act, 1912, amounts to 1,401,316,413 acres. Of the estimated

possible farm lands of this Dominion, it is stated that less than 15 per cent. is at present under cultivation. It will be understood, therefore, that the agriculture of Canada is still in its infancy and that the possibilities of crop production are almost unlimited.

The Canadian people in rural life are noted for physical strength, mental power, and moral stability. Surely Canada has before her a bright future.

WHEAT IN THE WEST

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I. *The First Wheat Crops in Western Canada.*—The earliest attempts at the cultivation of wheat in western Canada are associated with the vicissitudes of the Selkirk settlers and date from the year 1812. This little band of pioneers was sent out from Scotland by Lord Selkirk, *via* York Factory, to colonise 116,000 square miles of territory granted him by the Hudson's Bay Company (Fig. 40). An advance party of twenty-two men under the direction of Miles Macdonell arrived at the junction of the Red and Assiniboine rivers on August 30, 1812; and there they founded the Red River Settlement. To make provision for the future, they at once began to turn up the sod; and part of the breaking was sown with winter wheat brought from their native land. Some spring wheat having the same origin was also sown early in 1813. In the fall of that year, the settlers, whose number by this time had increased to nearly one hundred, were dismayed to find that the wheat harvest was a total failure. There was nothing to be done but to try again; but again Fortune refused to smile upon the newcomers, and the crop of 1814 was as bad as its predecessor. But Scotch persistency was to win in the end, for the third attempt at wheat-growing, made in 1815, was eventually brought to a successful conclusion.[1]

The failure of the first two crops of wheat was due partly to the fact that the earliest settlers to arrive at the Red river were crofters who knew more of fishing than of farming, and partly to the absence of adequate farm implements. There was not a plow in the whole colony, the one harrow was incomplete and could not be used, and all the labour of breaking up and working over the tough prairie sod had to be done with the hoe. The Indians looked on with surprise and amazement at the man with the hoe seeking to gain a sustenance from the soil, and to show their contempt for such work nicknamed the colonists "Jardiniers".

The first harvests stood in danger from the air, for each autumn flocks of birds, including the now extinct passenger pigeon, settled in

[1]In writing this article the author has drawn freely upon his *Essays on Wheat* (1919, The Macmillan Co., New York), to which the reader is referred for fuller details and references to the literature.

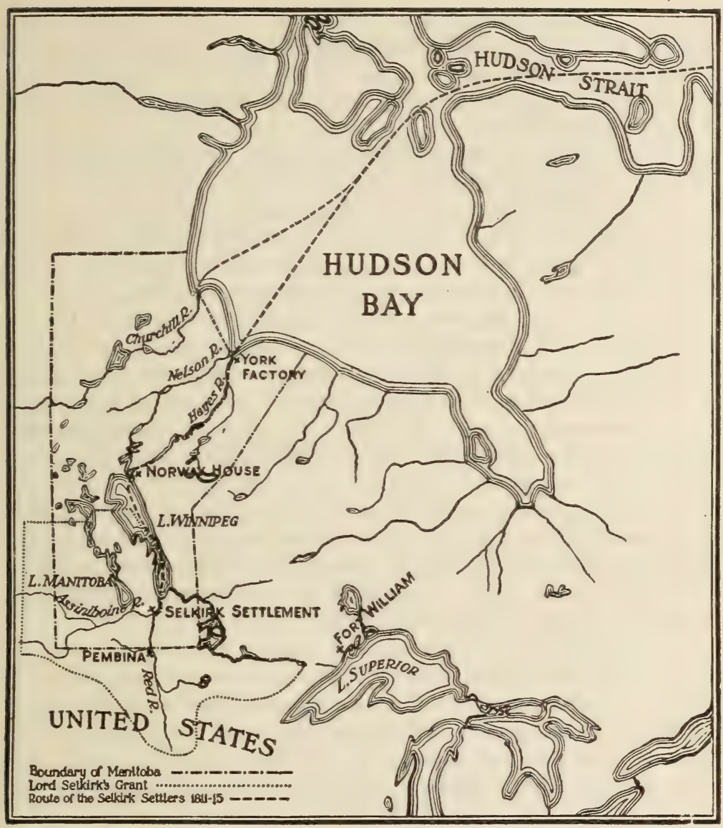

FIG. 40. MAP SHOWING LORD SELKIRK'S GRANT OF LAND, THE ROUTE OF THE SELKIRK SETTLERS, 1811-15, AND THE PRESENT BOUNDARIES OF THE PROVINCE OF MANITOBA

the fields and considerably diminished even such small crops as had been produced.

II. *Troubles with the North-West Company.*—The Red River settlers, in the first few years of their history, had not merely to struggle with nature to provide themselves with their daily bread but also with their fellow men. The North-West Company which, as fur traders, was the great rival of the Hudson's Bay Company, resented the establishment of a civilised community in the heart of the Indian country: first, because it was planted directly across their main line of communication between the northwest and Montreal and, secondly,

because it was situated on the very plains from which they drew their supplies of pemmican for their voyages from Fort William to the posts of the fur trappers. The company feared that the settlement might eventually destroy the fur trade, and they therefore determined to destroy the settlement.

In the spring of 1815, the Selkirk settlers sowed their wheat and barley; but many were the hardships to be borne before the crops could be reaped. In June, the North-Westers with their half-breed adherents overawed the colonists by a show of force. They trampled upon the crops, stole the horses, and burnt Fort Douglas, the colony mill, the stables and barns to the ground; and Miles Macdonell, the governor of the colony, surrendered himself as a prisoner. Most of the settlers left in North-West canoes for Upper Canada, and thirteen families made their way up Lake Winnipeg to Jack river and settled at a place now known as Norway House. John McLeod and three others, however, succeeded in weathering the storm and remained at the forks. They stored what property they could in a single log-house and stoutly defended themselves with a three-pounder cannon fed with lengths of chain obtained from the adjoining blacksmith's shop. Their half-breed assailants, who were on horseback, could not face this piece of artillery and soon desisted from their attacks. In the end, McLeod and his little garrison were left in peace to care for the crops and prepare for the return of their friends.

Colin Robertson, in charge of an expedition sent out by Lord Selkirk from Montreal, arrived at the Red river a few weeks after the expulsion of the colonists. On learning what had happened, he immediately pushed up Lake Winnipeg to the Jack river, persuaded the settlers to return, and brought them back in triumph. They were delighted to find that, during their absence, the crops had made good progress; and within a few weeks the first successful harvest was duly gathered in.

The new governor, Robert Semple, who had been sent out from Scotland by the Hudson Bay route, arrived at the Red River settlement on November 3, 1815. On finding that there were one hundred and twenty persons committed to his care, he at once began to feel anxious about the food-supply for the winter. Straightway he went to the granary where a rapid inspection revealed that the stores of grain consisted of from 12 to 14 stacks of wheat and barley. Would this satisfy the needs of the settlers and keep famine from their doors until the next harvest? A resort to mathematics could alone settle the question. Taking each stack as representing 50 bushels, he calculated that he had 400 bushels of wheat plus 200 bushels of barley. From these 600 bushels he deducted 40 for spring seed and so had 560 left.

Counting 50 pounds to the bushel, he calculated that the grain which could be used as food amounted to 28,000 pounds. He then reckoned that 120 persons at 2 pounds per day would consume 240 pounds per day, and that this was equal to 7,200 pounds per month or 28,800 pounds for 4 months—an amount of grain but little more than the 28,000 pounds he actually had at his disposal. And so the settlement would be free from the trials of hunger throughout the winter of 1815-16. "How was my heart relieved," writes Semple to Lord Selkirk, "when I arrived at the end of this simple calculation which I tried again and again for fear of a mistake."

In the spring of 1816 the settlers sowed the forty bushels of seed wheat and seed barley which had been saved from the crop of the previous year, but alas for their hopes of harvest! Within a few short weeks, when every field was putting on its summer garb of green, the colony was to be broken up once more, and a goodly number of the settlers were to find their graves. The quarrel between the rival companies came to such a pass that, on June 19, a bloody combat took place between their forces. A boy on the watch-tower of Fort Douglas sighted a large gathering of hostile half-breeds; and Governor Semple and about thirty of his men went out to meet them. At a spot known as Seven Oaks, a few miles north of Winnipeg near the Red river, the two parties came together. The half-breeds were painted and disguised. Hot words were exchanged, a shot was fired, and in the fight which followed Governor Semple and twenty of his men were left dead upon the field. The rest of the settlers in bereavement and despair made their way up Lake Winnipeg and, after a long and wearisome journey, again took up their abode at Jack river. The North-Westers occupied Fort Douglas until the end of the year; and, after this second expulsion, no colonist was permitted to remain to gather in the crops.

Early in 1817, in the depth of winter, a force sent from Fort William by Lord Selkirk wrested Fort Douglas from the North-West Company. A surprise attack was made in the dead of night: the walls were scaled, and the sixteen men within were all made prisoners. When daylight came, the flag of the Hudson's Bay Company was again hoisted on the staff. With the arrival of spring, an express canoe was dispatched to Jack river with the news that Fort Douglas had been taken. The settlers were persuaded to return, and, in the hope that peace might finally be established, resumed their agricultural pursuits. However, the facilities for tilling the soil were extremely limited and it was still necessary to use the hoe in place of the plow. Wheat was sown although late in the year and, owing to its scarcity, in small quantity. It grew well but, in the autumn, the crop was almost ruined by a violent hurricane. So short of cereals were the colonists during

the winter of 1817-18 that they had to rely upon the buffalo as a chief source of food.

III. *Visit of Lord Selkirk.*—Lord Selkirk, who was an experienced agriculturist, arrived at the settlement in the summer of 1817, and for four months exercised a wise and generous supervision over its affairs. His heart was in this work, for he had great visions of the future. His belief in the possibilities of the western prairie-land he once expressed in a remarkable prophecy: "It is a very moderate calculation to say that if these regions were occupied by an industrious population, they might afford ample means of subsistence for thirty millions of British subjects." So anxious was Lord Selkirk to encourage agriculture that before his arrival, in 1815, he had authorized Semple and Robertson to offer on his behalf a prize of £50 to the farmer who should raise the largest quantity of grain in proportion to the number of hands employed.

Lord Selkirk left the settlement on September 9, 1817, for Montreal in order to answer charges brought against him at the instigation of the North-West Company. The litigation in which he became involved affected his health, which he attempted to recover by a visit to Pau in France. There his end came on April 8, 1820; and the man whose indomitable spirit caused the sowing of the first fields of wheat in western Canada and who, with the insight of a seer, foresaw the present and the future agricultural prosperity of the far-spreading prairie-land, now lies buried in a French graveyard. The North-West Company and the Hudson's Bay Company settled their differences by amalgamation in 1821, a year after Lord Selkirk's death.

IV. *The First Farms.*—The Red River Settlement, in the first few years of its existence, concentrated its farming operations in what is to-day known as the municipality of Kildonan. It was arranged that each settler should purchase one hundred acres of land at five shillings an acre, but Lord Selkirk relinquished his claim to payment, when he visited the colony in 1817, in order to help the settlers who had suffered so much in the two previous years. For the purpose of giving each farmer access to the main highway—the Red river—and to secure the advantages of compactness for the colony as a whole, the farms were all made long and narrow with one end fronting on the water, and were placed side by side in a parallel series.

V. *The St. Paul Railway.*—Soon after Manitoba had been organised as a province (1870), settlers began to pour into it from the south. Immigrants from Ontario and the old country were compelled to come through the United States to Chicago, then northwest to St. Paul, and then northwards across 450 miles of level prairie. For eight years a stream of immigrants made the long journey into Manitoba by wagon, by coach, and by Red River steamer; and great was the relief

to the traffic when at last, in 1878, the first railway entered the province from the south. This new means of communication gave a direct connexion between St. Paul in Minnesota and the little town of St. Boniface on the right bank of the Red river. On arriving at railhead, the settler, in order to get to Winnipeg, had merely to cross the river in a ferry boat.

VI. *The Canadian Pacific Railway.*—The St. Paul Railway was a great boon and formed a splendid link with the United States; but something still was lacking. The rising spirit of Canada, supported by the voice of Manitoba, demanded that an all-Canadian railway should be built across the continent, so as to give the west a direct connexion with the east. This great project was eventually brought to a successful conclusion, with the result that in 1886 there took place an event of outstanding significance for the subsequent development of wheat-growing in western Canada: there passed through Winnipeg on Dominion Day, July 1, the first through train from Montreal to Vancouver. Its engine, *Canadian Pacific Railway No. 1*, ran upon a line of steel destined to bear to the country's ports hundreds of millions of bushels of wheat required to satisfy the world's craving for bread.

A grain of wheat is a very tiny thing in itself, but the prosperity of western Canada is bound up with its existence; and it is not too much to say that without the grain of wheat in its collective form the great and thriving city of Winnipeg, with its population of 200,000 souls, its imposing buildings, its fine streets, and its busy cosmopolitan life, would scarcely have advanced at the present time beyond the status of a small trading station. The growth of Winnipeg from a village of 215 people in 1870 to its present proportions has been due in large measure to the construction of the Canadian Pacific Railway, the connecting of the east and west parts of Canada by a band of steel. Through mile after weary mile for hundreds of miles was the track pushed from the east, past lake and swamp and stream, onwards amid the lonely forests of pine and poplar, of spruce and birch, on, on, through all that long stretch of rocky boulder-strewn country north of the Great Lakes which was swept bare of soil in the dawn of human history, onwards and ever onwards, until at last it reached the west. All the vast difficulties in the path of the engineers were overcome because the men behind the Canadian Pacific Railway were men of vision, men who could see in the mind's eye under the blue dome of heaven the golden grain which would come to clothe the fertile acres of the broad prairie-land. Surely the brightest dreams of the founders of the Canadian Pacific Railway have been amply justified by events.

The completion of the eastern half of the Canadian Pacific Railway immediately provided that direct connexion with the old country

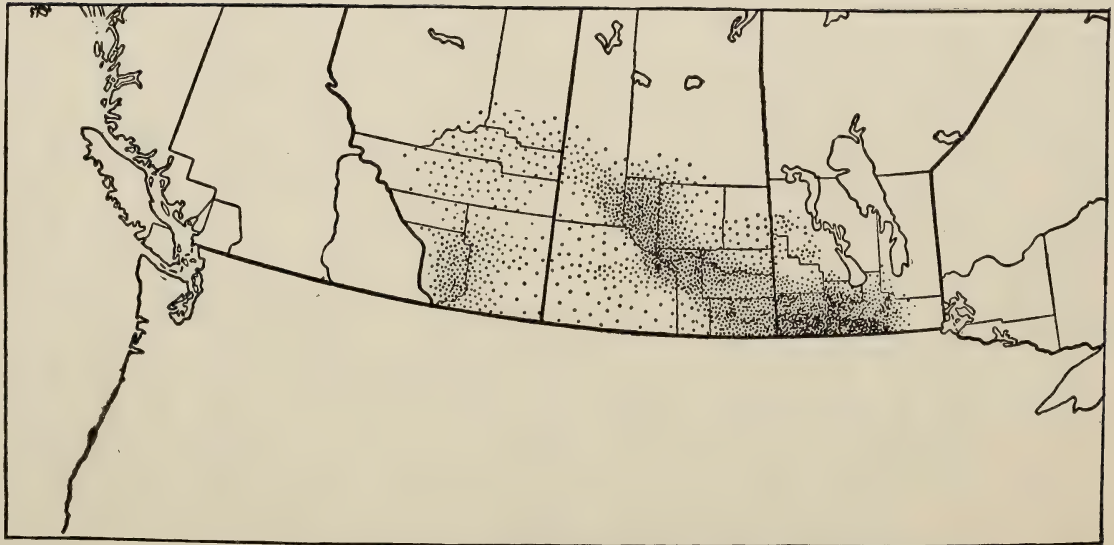

FIG. 41. COMBINED ACREAGE OF SPRING-SOWN AND AUTUMN-SOWN WHEAT IN WESTERN CANADA

Each dot represents 5,000 acres. From *Geography of the World's Agriculture*, by V. C. Finch and O. E. Baker. Courtesy of the United States Department of Agriculture.

market for which Manitoba had been longing; and soon the agricultural progress and prosperity of the west were assured. The tide of immigration grew ever stronger and Winnipeg became the great gateway to the new land of promise. The buffalo disappeared, the Indian gave place to the white man, and vast tracts of the virgin prairie were turned with the plow. The wheat of the prairie provinces, on account of its high quality, acquired universal fame, and Canada came to be called the Granary of the British Empire. How well that granary served the cause of the allies in its time of trial needs no telling, for it is known to the whole world.

VII. *Wheat-growing at the Present Day.*—The rapid progress made by western Canada in recent decades is reflected by the crop returns, some of which are as follows:

1904	56,000,000 bushels	
1906	102,000,000 "	
1913	209,000,000 "	
1915	360,000,000 "	
1923	460,000,000 "	(approximately).

Last year, 1923, the western wheat crop was by far the largest on record. Canada herself is able to use about 100,000,000 bushels, and thus the 1923 crop has provided about 360,000,000 bushels of wheat for export. When it is remembered that as yet not one-half of the good agricultural land of the west is under the plow, the confidence of western Canadians in the future of their half of the Dominion seems to be well justified. At the present time Canada is the greatest wheat-exporting country in the world and in this respect now far surpasses her southern neighbour, the United States.

The chief wheat-growing province is now Saskatchewan, after which comes Alberta and then Manitoba (1923). In Fig. 41 is reproduced a map, originally published in 1917, which shows the acreage sown to wheat in the three prairie provinces. In 1923 the total area under wheat in these provinces was 21,665,000 acres.

Winter wheat has a higher yield than spring wheat, wherever it can be successfully grown. However, on account of climatic conditions very little winter wheat is grown in western Canada. In 1923 the acreage devoted to winter wheat in the west was only two-fifths of one per cent. of the total wheat acreage. Manitoba, Saskatchewan, and Alberta must therefore be thought of as spring-wheat provinces.

The wheats sown in spring are hard red varieties, the chief sort being *Marquis* which has now practically replaced the old standard *Red Fife*. The winter wheats sown in the autumn in Alberta are chiefly *Turkey Red* and *Kharkov*. In dry parts of southern Alberta and southern Saskatchewan, durum wheats are grown to a small extent, but their culture may be considerably increased in the future.

The virgin prairie is usually broken in the month of June. Its surface is then cultivated and left uncropped until the following spring. Thus the prairie grasses, etc., are prevented from growing and using up moisture, and the moisture is stored and conserved in the newly-broken land.

Until recently, but little or no attempt was made to apply manure or fertilisers to the land, and the grain fields were cropped year after year without anything being added to them. Of late, however, with the introduction of mixed farming, farm-yard manure has come to be commonly used, particularly on lighter soils. This practice has been found to increase the yield of the crops on soils which have long been cultivated and thus to add to the profits of farming.

On account of the low rainfall, moisture limits the yield of grain per acre. The bare fallow, or some modification of it, is therefore resorted to once in from two to five years, more often in the dryer districts and less often in the more humid ones. The summer fallow is the basic practice of dry farming. Its purpose is to store moisture in the soil by means of a soil mulch created by surface tillage. The surface tillage breaks the capillary tubes in the soil and so lessens evaporation.

In older districts the summer fallow has a double function, for it is not only used to conserve moisture but also to control weeds. Among the annual weeds which have proved to be pests are wild oats (*Avena fatua*) and various members of the mustard family; and, among the perennials, sow thistle (*Sonchus arvensis*), canada thistle (*Cnicus arvensis*), and quackgrass (*Agropyron repens*). The very dry parts of southern Alberta and Saskatchewan are troubled with the Russian thistle (*Salsola Kali*). Practically all the noxious weeds of the west have been introduced directly or indirectly from Europe.

The seed-wheat, before being sown, is usually cleaned by passing through a fanning mill and then treated with *formalin* to kill any spores of the stinking smut fungus (*Tilletia Tritici*) which may be clinging to the kernels and which, if not destroyed, might germinate on the kernels in the soil, infect the seedlings, and cause smut-balls instead of sound kernels to be produced in the heads of the diseased plants.

The wheat grower endeavours to prepare the land to be sown so that it shall be well stored with moisture, free from weeds, firm, and mellow. After seeding in such soil at a depth of from one to three inches, the depth varying with the soil's moisture content, the land is generally firmed down by using a packer and then harrowed to create a mulch to lessen the evaporation of moisture. Seeding is accomplished by means of a large drill drawn by a team of horses or an engine, and

is usually completed between the middle of April and the tenth day of May. The crop usually heads out during the first half of July and ripens between the tenth of August and the twentieth of September.

The crop is harvested by means of self-binders drawn by horses or by tractors. Each binder cuts a width of from six to eight feet and, at the same time, ties the grain into bundles or sheaves which are thrown to the ground. The sheaves are then placed in stooks or shocks by men who follow the binder as closely as possible. The grain is separated from the straw by means of large threshing machines drawn by tractors and having a capacity of from 500 to 2,000 bushels per day.

The harvesting and threshing season is the busiest part of the year in western Canada. To assist in relieving the labour shortage, which is always felt at this time, some 20,000 to 30,000 extra harvesters are annually brought to the prairie provinces from the east of the Dominion and from the United States. In 1923, 12,000 additional harvesters came to western Canada from the British Islands.

The western plains, in general, are very level and free from large trees, and hence are easy to break with the plow. The soil is thick and rich in humus, and gives a good crop from the first. The chief difficulties of wheat-raising arise from temporary droughts in summer, drying winds, early fall frosts, occasional severe attacks of the Black Stem Rust disease, and local hailstorms. Rain, however, seldom falls in too large a quantity, and the weather during the harvesting and threshing season is usually dry and bright. There is no more exhilarating sight in the west than the prospect of the binders at work on the sea-wide, sky-skirted prairie, with the golden grain gleaming under the August sun and above and about all the cloudless blue dome of heaven. And when the last sheaf has been cut and the binders are silent, how splendid is the view across the gently rolling stubble fields: stook beyond stook, stook beyond stook, for a quarter of a mile, for half a mile, and still more stooks as far as the eye can see, stooks cresting the distant horizon, ten thousand stooks all waiting to be threshed and each with its promise of bread, the gift of the New World to the Old (Fig. 42).

VIII. *Marquis Wheat.*—All the Marquis wheat in existence originated from a single grain planted by Dr. Charles Saunders in an experimental plot at Ottawa in 1903. Of this kind of wheat, in North America, 250,000,000 bushels were raised in 1917, 300,000,000 bushels in 1918, and upwards of 500,000,000 bushels in 1923. Marquis is the offspring of a cross between Red Fife (male parent) and Hard Red Calcutta (female), the former excelling in milling and baking qualities and the latter in earliness. Marquis yields more highly than Red Fife and other wheat varieties which it has replaced, and its productiveness

Fig. 42. WHEAT IN THE STOOK IN WESTERN CANADA

Courtesy of the Immigration and Colonisation Branch of the Government of the Province of Manitoba.

was a factor of considerable help to the allies in the great war. Dr. Charles Saunders, who by discovering and introducing Marquis wheat increased the wealth of Canada and the United States by many millions of dollars, recently retired from his position of Dominion Cerealist on account of ill-health and, for the present, is residing in France.

IX. *Elevators.*—To store the grain produced on the farm before it can be exported or otherwise used, special warehouses, known as *elevators*, are provided. The wheat is *elevated* into these buildings by machinery and deposited in bins. The bottom of the shipping bin is always situated at some distance above the level of the ground and opens into a movable spout on the exterior of the elevator. When it is desired to ship wheat away from an elevator, advantage is taken of the flowing property of grain in bulk: the spout is opened and the grain falls through it by gravity and passes into a box-car or the hold of a steamer.

Elevators are of several kinds. There are *country elevators* along the railways for receiving grain from the farmers for storage before it has been inspected, *terminal elevators* which receive or ship grain and which are located at points declared to be terminal so far as inspection is concerned, *hospital elevators* which are used for cleaning or specially treating rejected or damaged grain and which are equipped with machinery for that purpose, and *mill elevators* which are used or operated as part of a plant engaged in the manufacture of grain products. In the Western Inspection Division of Canada, for the license year 1922-23, there were 1,564 railway stations having elevators, the number of elevators was 3,996, and the total capacity of all the elevators together was 204,000,000 bushels.

A terminal elevator at Fort William or Port Arthur (Fig. 43) is situated upon the lake front, so that the grain which it contains may be passed directly into the hold of a lake steamer. It is usually divided into two parts: the *working house* and the *storage bins*. The working house is rectangular in shape, much higher than it is long or broad, and has numerous windows in its upper half. Here the wheat is received from the railway box-cars, elevated, weighed, temporarily stored in smaller bins, and cleaned. Here, too, are situated the shipping bins from which the wheat passes into the freight vessels. The storage bins, on the other hand, are great concrete cylinders which stand vertically upright and are connected by concrete where they are in contact. There may be several parallel rows of them. The space between every four adjacent cylinders is not wasted but is used as a smaller bin. Running over the top of each row of bins is a passageway which leads from the upper part of the working house. The grain is conveyed along these passages and is deposited in the bins from above.

Each bin can be filled from the bottom to the top, and a single cylinder may hold as much as 30,000 bushels of grain. Under each row of bins there is a tunnel leading to the base of the working house. The wheat is let out of a bin through a hole in its base. The capacity of an elevator depends on the size and number of its cylindrical storage bins. The bins are cylindrical because engineers have found that cylindrical bins resist the pressure of the grain within better, and require less concrete in their frame, than bins of any other form. The different grades of wheat are kept in separate bins. When a car-load of wheat has been put into a bin with other wheat of the same grade, it loses its identity

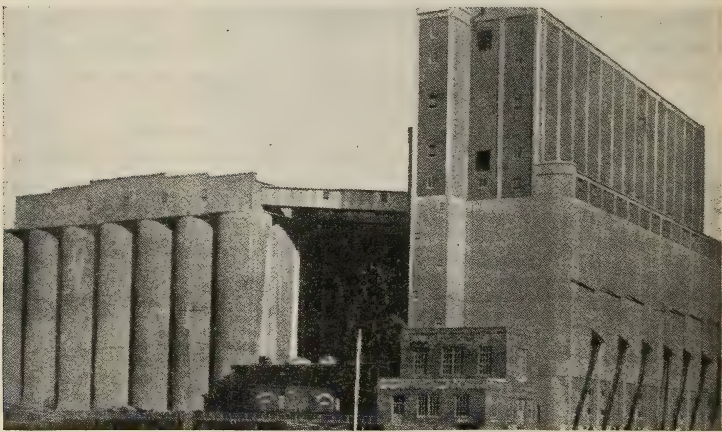

FIG. 43. THE DOMINION GOVERNMENT TERMINAL ELEVATOR AT PORT ARTHUR

Railway track in front, storage bins on the left, working house with its shipping bins on the right. The spouts hanging from the shipping bins can be directed into the hold of a lake steamer. From R. Magill's *Grain Inspection in Canada.* Courtesy of the Board of Grain Commissioners.

and cannot again be recovered. Wheat in a terminal elevator is therefore stored in bulk according to grade.

The passage of wheat through a terminal elevator is by far the cheapest and most efficient means of taking it from box-cars and getting it on board a lake freight boat, for loading simply consists of letting the wheat out from a shipping bin through a spout so that it flows by its own weight into the hold. The rapidity with which the cargo boats can be loaded from a terminal elevator is truly astonishing. The average loading run to any boat is about 30,000 bushels an hour; but the record speed for loading at the head of the lakes is 130,000 bushels

in one hour. This record was made at Fort William, at the Western Terminal Elevator, in September, 1923.

X. *Sampling and Grading of Wheat.*—An essential element in the grain business of western Canada is the classifying or *grading* of grain by government inspectors. The wheat is bought, sold, transported, and stored in bulk according to grade.

The work of grading is largely concentrated at Winnipeg. When a grain train from the west arrives at Winnipeg, a sample of wheat is obtained from each car and then taken to the Dominion inspection office. The inspectors there determine the grade of wheat in each car from the sample supplied. During the busy season as many as 2,000 cars are often graded by the Winnipeg inspectors every day.

XI. *Vancouver and the Panama Route.*—The opening of the Panama canal presented the possibility of shipping Canadian wheat to Europe from ports on the Pacific coast. In 1917, a test experiment was made with wheat loaded at Vancouver. A cargo of grain, with experts from the Dominion Grain Research Laboratory on board, was taken from Vancouver down the Pacific coast, through the Panama canal, and across the Atlantic to London, the voyage occupying three and a half months. This initial shipment of grain *via* the Panama canal was successfully carried out, with the result that Vancouver in the past few years has been rapidly developing into a great grain-exporting port. During the crop-year 1922-1923, this city exported some 18,000,000 bushels of western wheat and, during the first six months of the crop-year 1923-1924, 24,000,000 bushels; and doubtless, in the future, this business is destined to grow. A great advantage enjoyed by Vancouver as compared with Montreal and Quebec lies in this: that, whereas the eastern ports are frozen up during the winter, the western one is open the whole year round.

As the prairie provinces develop and the world's demand for Canadian wheat increases, it is to be expected that Canada's surplus wheat will flow out from the country not only through ports on the Atlantic and Pacific coasts but also through the Hudson bay, for the sea route from Port Nelson on the Hudson bay to the British market is shorter than that from New York.[2]

[2]For bibliography see appendix.

DAIRYING IN CANADA

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Dairying began in Canada during the early part of the seventeenth century. The Province of Quebec has the honour of being the first of the provinces to give a start to what is now the most important branch of agriculture in this country. "All authorities agree that the French Canadian breed of the present day is descended from the stock imported from Normandy and Brittany in the 17th century." (Ruddick). This is the only breed of cattle which originated in Canada. It is now recognised as a pure breed. Breeders of French Canadian cattle have a herd book and issue pedigrees.

The provinces of Ontario and Quebec have always been leaders in the production of dairy goods, but the western provinces are making rapid progress in dairying and it may not be many years before there will be more milk produced west of the Great Lakes than is now obtained from the eastern part of Canada.

Up to the year 1864, practically all the dairy products were manufactured on the farms and chiefly consisted of butter, which was of poor quality and sold for a low price. The factory or co-operative system was started in western Ontario by the late Harvey Farrington who came to Canada from New York State in 1863. At first, cheese only was made in factories, but in 1875 a creamery for the manufacture of butter was built at Teeswater, Ontario. The cream was collected from farms, where it was raised on deep cans set in cold water. The cream is still collected from farms, but most of it is obtained by the separator or centrifugal system. Machines for this purpose are now so perfect and so comparatively cheap, that nearly every farmer who has five or more cows and sells cream or makes butter owns a cream separator. These farm separators are chiefly operated by hand, but on some farms by a small engine or motor. In the "Hydro-belt" the electric motor is the most popular source of power for running a cream separator.

There are in Canada, also, creameries where whole milk is delivered to the factory, and the cream is separated by power machines having a capacity of 5,000 to 6,000 pounds of milk per hour. The cream is either made into butter or sold as sweet cream for ice-cream making,

or table use. The by-products, skim-milk and buttermilk, are sometimes returned to the farm for feeding to live-stock, but more often are condensed or powdered and the product used as human food.

The tendency in the older dairy districts of Canada is to make less cheese and more butter, condensed and powdered milks, and ice-cream, and, also, to supply more milk and cream for direct consumption in the towns and cities. A large proportion of the butter made in Canada is consumed at home. In fact, at certain seasons, butter is imported for local consumption. As our population increases we shall probably cease to be an exporting country for dairy products, as is the case in the United States, into which country large quantities of butter and cheese are imported notwithstanding a heavy duty or tariff against dairy goods brought in from foreign countries.

A reorganisation of our system of marketing dairy products is under way. For the first time in the history of Canadian dairying, all cheese and butter for export has been "graded" by the government inspectors during the season of 1923. Compulsory grading of cream used in butter-making and payment for the same according to grade, began in the western provinces in 1922. The Province of Nova Scotia has a similar system and it will not be long before the other provinces fall into line. In Ontario, voluntary cream-grading has been followed by a few creameries for the last two seasons. Competition is so keen among the operators of creameries in Ontario, that it is difficult to secure a compulsory law for cream-grading, or even to get "gentlemen's agreements" lived up to strictly.

In order to build a successful dairy industry it has been necessary to pay special attention to the foundation, which is on the farm. Governments, both federal and provincial, have sought to aid the farmer in the production of milk and cream in larger volume and at less cost. Encouragement is given to farmers through "Record of Performance" testing, whereby cows of all pure-bred ancestry which come up to certain standards of milk and fat production are given recognition by the federal Department of Agriculture, the testing of the milk being done by government inspectors free of charge. "Accredited Herds" are being established under federal supervision whereby farmers may have cows tested for tuberculosis without charge and receive compensation for "reactors". It is hoped that by this plan our dairy herds may be free from this disease, which causes serious losses in some localities, particularly among those herds which are pure-bred, where values of single animals frequently run into thousands of dollars. The two world-champion milk cows are owned in Canada—one in British Columbia and one in Quebec—each having a record of over 30,000 pounds milk in one year, and one of them nearly 1,700

pounds of butter in 365 days under strictly official testing. These cows are very valuable and owners of such cattle cannot afford to take any chances with disease in their herds. For the man who owns grade cows, the Cow-testing Association has been a valuable help in ascertaining the individual milk- and butter-producing capacity of the cows in the herd. In this case, the farmer weighs the milk from each cow three days in each month and takes samples which are tested by the government free of charge for milk-fat or butter content. As all milk and cream in Ontario must be purchased for butter manufacture according to its fat content, and as all milk for cheese-making, condensing, and powdering is purchased (by law) on the basis of its fat content, it is very necessary that the owner of cows shall know not only the weight of milk given by each cow in the herd but also the fat content of her milk.

Next in importance to the cow herself is her feed. Grass is the chief summer feed for cattle in Canada. The southern part of the Province of Ontario is practically surrounded by great fresh-water lakes, causing the climate in summer to be much like that of the British Isles, Denmark, Holland, and New Zealand, where are to be found the best dairy farms in the world. The growing of corn (maize) and the filling of silos for preserving green feed, together with the growth of clovers preserved in the form of hay or silage, with the addition of concentrates such as oats, wheat bran, oil-meal, and other by-products, are helping to solve the problem of winter feeding of dairy cows. Suitable stabling, also, is necessary for housing milk cows during the period of cold weather when the temperature frequently falls below zero in eastern Canada, and very much lower in the western provinces.

The introduction of the milking machine has been a great help where labour is scarce and where it is difficult to secure the services of good hand-milkers. As these machines come into more general use, they will enable the farmer to keep more cows. This means larger herds of milking animals per farm which will enable the manufacturer to obtain larger supplies of milk and cream nearer to the factory, thus reducing the cost of transportation for raw material, and lessening the cost of manufacture per pound of butter or cheese made. The costs of transportation and manufacturing make a large item in the bill which the farmer has to pay in order to get his raw material changed into a concentrated, non-perishable, easily transported form of human food, such as butter, cheese, condensed and powdered milk. Anything that can be done to lessen the charges made for manufacturing these dairy products means that much greater returns for the dairy farmer, as in practice, the other classes engaged in the dairy business exact their toll, and the farmer takes what remains after the others are paid

for their labour and other costs. Co-operative manufacturing and marketing is the ideal for the Canadian dairy farmer, but he is much short of that ideal at the present time. The dairy business has got into certain grooves and channels, and these are not easily changed. In spite of the drawbacks mentioned, dairying is one of the most dependable and remunerative branches of agriculture in Canada. "Prosperity follows the Dairy Cow."

THE FRUIT INDUSTRY OF CANADA

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Historical.—The commercial fruit industry of Canada is of comparatively recent development, but fruit has been cultivated in Canada since the early part of the seventeenth century, when the French settlers in Acadia, now the Province of Nova Scotia, and those who settled along the banks of the St. Lawrence, in what is now the Province of Quebec, brought with them from France seeds and trees which they planted and from which sprang the first orchards and fruit gardens of Canada. The commercial side of fruit growing is a development of the past sixty or seventy years.

Kinds of Fruit Grown in Canada.—The principal fruits grown for sale in Canada are apples, pears, peaches, plums, cherries, apricots, grapes, blackberries, cranberries, currants, gooseberries, loganberries, raspberries, and strawberries, but there is also a large quantity of blueberries, huckleberries, and other wild fruits sold which are picked from plants in the wild.

Where Fruit is Grown in Canada.—A very large area of land in Canada is suited to the growing of fruit. The apple is grown most extensively in the provinces of Ontario, Nova Scotia, Quebec, and British Columbia, but this fruit succeeds well also in the provinces of New Brunswick and Prince Edward Island. This fruit may be grown successfully also in favourable locations in the prairie provinces of Manitoba, Saskatchewan, and Alberta, but the quantity grown is very limited as yet, and it may be said that crab apples are more generally successful on the prairies than the apple at present.

The pear is grown mainly in the provinces of Ontario and British Columbia, though it succeeds well in the milder parts of Nova Scotia, and the hardiest varieties can be grown successfully in Quebec, New Brunswick, and Prince Edward Island.

Plums find most congenial climatic conditions in Ontario, Nova Scotia, and British Columbia, but the hardier varieties of the European or Domestica plum are grown successfully for sale in the provinces of Prince Edward Island, New Brunswick, and Quebec. The native species, *Prunus nigra* and *Prunus americana*, are cultivated in the

colder parts of the Dominion, the improved varieties finding a ready sale. In the prairie provinces the earliest varieties are the most reliable.

The largest quantity of cherries is produced in the Province of Ontario, but in British Columbia they are much grown also, the sweet cherry doing particularly well there. Cherries are also grown to a limited extent in the provinces of Nova Scotia and Prince Edward Island, and in parts of Quebec, the sweet cherry doing very well in the warmer parts of Nova Scotia.

Most of the peaches are grown in southwestern Ontario, and particularly in the Niagara peninsula, but they are also grown quite successfully in the warmer parts of British Columbia. They can be grown in the Annapolis and adjacent valleys in Nova Scotia, though they are not raised in commercial quantities there.

The grape industry is confined mainly to southwestern Ontario, but grapes can be grown in all the other provinces of Canada. In the prairie provinces only the earliest and hardiest varieties are grown and these only for home use.

Small fruits such as currants, gooseberries, raspberries, and strawberries have a very wide adaptation in Canada and can be grown by the settlers practically everywhere. The blackberry, however, is a tenderer fruit, and is grown principally in the warmer parts of Ontario and British Columbia. The commercial cultivation of the loganberry is confined almost altogether to the lower mainland of British Columbia and to Vancouver island, though they are grown for sale to a considerable extent in certain places in the upper country.

Canadian Fruit Statistics.—The importance of the fruit industry of Canada may be realised by a study of the following figures, which are the latest that it has been possible to procure, most of them having been obtained from the Dominion Census of 1921:

NUMBER OF APPLE TREES IN CANADA AS PER CENSUS OF 1921

Province	Bearing	Non-bearing
British Columbia	1,625,696	515,821
Alberta	14	259
Saskatchewan	26	204
Manitoba	703	2,542
Ontario	4,492,672	987,115
Quebec	779.394	556,899
Prince Edward Island	132,678	22,162
New Brunswick	397,338	145,358
Nova Scotia	1,822,396	294,049
Total	9,250,917	2,524,409

COMMERCIAL APPLE PRODUCTION IN CANADA

		Barrels	Value	Average value per barrel
CANADA	1921	4,406,813	$29,898,649	$7.39
	1922	3,838,852	19,508,211	5.08
	1923	3,240,000		
Nova Scotia	1921	2,036,065	13,478,750	6.62
	1922	1,891,852	7,851,186	4.15
	1923	1,500,000		
New Brunswick	1921	33,000	170,940	5.18
	1922	25,000	112,500	4.50
	1923	10,000		
Quebec	1921	35,200	251,328	7.14
	1922	112,500	787,500	7.00
	1923	33,000		
Ontario	1921	885,065	6,850,403	7.74
	1922	809,500	4,007,025	4.95
	1923	650,000		
British Columbia	1921	1,057,483	9,147,228	8.65
	1922	1,000,000	6,750,000	6.75
	1923	1,047,000		

STATISTICS OF OTHER FRUITS

Fruit trees	Bearing	Non-bearing
Crab apples	167,375	29,349
Peaches	993,863	167,552
Pears	440,168	156,950
Plums and prunes	854,842	334,283
Cherries	579,569	168,765
Grapes	32,614,805 lbs.	
Strawberries	14,631,121 qts.	

CANADIAN EXPORTS OF APPLES

	Barrels	Value	Value per Barrel
1914	947,382	$3,465,475	$3.73
1919	405,058	2,041,076	5.03
1920	873,882	4,242,219	4.85
1921	1,358,499	8,299,099	6.10
1922	1,845,955	8,854,379	4.80

CANADIAN EXPORTS OF OTHER FRUITS

	1914	1919	1920	1921	1922
Berries	$ 91,935	$ 70,830	$ 229,656	$377,230	$ 309,318
All other fresh fruits	220,147	41,805	142,719	570,252	584,825
Apples dried	411,789	166,591	514,727	315,372	535,995
Fruits canned	394,719	1,805,434	3,174,239	751,520	1,295,725
Vegetables canned	17,655	9,154,622	1,527,202	408,203	321,635

CANADIAN IMPORTS OF APPLES

	Barrels	Value	Value per Barrel
1914	330,907	$1,104,302	$3.36
1919	281,316	1,372,644	4.87
1920	145,088	1,053,744	7.26
1921	273,319	1,528,606	5.59
1922	110,702	680,832	6.15

Production of Fruits in Canada in 1923

Province	Strawberries Quarts	Raspberries Quarts	Other Berries Quarts	Cherries Bushels	Peaches Bushels	Pears Bushels	Plums Bushels	Grapes Pounds	Apples Barrels
Prince Edward Island	......	......	......	......	......	......	......	......	......
New Brunswick	500,000	16,995	24,000	......	......	......	......	......	69,292
Nova Scotia	135,000	36,080	112,500	......	......	20,500	......	......	1,500,000
Quebec	510,000	......	......	......	......	......	......	......	65,094
Ontario	3,607,200	840,000	950,000	103,125	332,860	112,000	83,100	42,185,077	1,304,400
Manitoba	......	......	......	......	......	......	......	......	......
Saskatchewan	......	......	......	......	......	......	......	......	......
Alberta	......	......	......	......	......	......	......	......	......
British Columbia	3,900,000	3,603,765	1,441,200	100,000	70,800	94,835	265,382	......	1,124,933

FIG. 44. GRAVENSTEIN APPLE TREE IN NOVA SCOTIA
This tree is 150 years old and still bearing well.

Fruit Varieties and Fruit Breeding.—Only a small proportion of the varieties of fruits being grown commercially in Canada were originated in the Dominion. Most of them had their origin in the United States, Great Britain, or Europe. This is because these countries had been cultivating fruits in large quantities long before the fruit industry had developed to any great extent in Canada; consequently, there were more good varieties to choose from.

Following are some fruits of known Canadian origin that have appeared in the trade, the most noteworthy of these being the Fameuse and McIntosh apples, both varieties unexcelled in quality in the world and the latter now being grown in enormous quantities both in Canada and the United States:

Apples—Fameuse, McIntosh, St. Lawrence, Ontario, New Brunswick, Canada Baldwin, Banks Gravenstein, Swayzie Pomme Grise, Baxter, Trenton, Crimson Beauty.

Peaches—Fitzgerald, Banner, Tyehurst.

Pears—Dempsey, Ritson.

Plums—Glass Seedling, Mount Royal, Raynes, Mammoth.

Cherries—Windsor.

Grapes—Brant, Canada, Moyer, Burnet, Kensington, Jessica.

Raspberries—Herbert, Hilborn, Smith Giant.

Black Currants—Saunders, Beauty, Kerry, Magnus, Clipper, Climax, Eagle, Topsy.

Gooseberries—Pearl, Josselyn (Red Jacket), Mabel, Charles, Silvia.

Strawberries—Williams, Portia.

Breeding Fruits.—Enthusiastic amateur Canadian horticulturists began the breeding of fruits in Canada between fifty-five and sixty years ago, and a number of the varieties listed above are the result of hand pollination or special effort. During the past thirty years the Dominion and provincial governments have given much assistance in fruit breeding, and this is now an important feature of the work at the Central Experimental Farm, Ottawa, Ont.; the Horticultural Experiment Station, Vineland, Ont.; the Ontario Agricultural College, Guelph, Ont.; and is being begun in other parts of Canada.

Most of the earlier work was done at Ottawa, where cross-breeding was begun in 1894, but where open pollinated seedlings were grown since 1890. This earlier work was confined mainly to the apple. Thousands of new varieties of apples have been grown and fruited as the result of this work, and the best of these have been propagated and distributed for test. Of the varieties which have been named, the Melba and the Lobo, two open pollinated seedlings of the McIntosh, have commanded the greatest attention, and are among the most promising. Much work has been done also in originating varieties, which, it was hoped, would be suitable for the prairie provinces of Canada, the wild Siberian crab, *Pyrus baccata*, being used as one of the parents. As a result of this work and after testing hundreds of the cross-bred trees under very trying climatic conditions on the prairies the Osman and

the Columbia have been found hardy under the most trying conditions, and these, though but the size of crab apples, are being re-crossed in order to obtain, if possible, an apple of commercial size which will retain the hardiness of these parents.

Other fruits used in breeding work at Ottawa include the pear, plum, cherry, grape, currant, gooseberry, raspberry, strawberry, and blueberry. At Vineland, Ont., much work in cross-breeding has been done with the peach, grape, strawberry, and other fruits, and some of the varieties resulting from this work are being introduced. At the Ontario Agricultural College, Guelph, Ont., good work in fruit breeding has been done, especially with the apple and strawberry.

Cultivation of Orchards and Other Fruit Plantations.—Canada is so large a country and has a climate so varied that the methods of cultivation must necessarily vary somewhat. In the great fruit districts of Ontario and Nova Scotia the practice is to cultivate the orchards until about the middle of July, when seed for a cover crop is sown. The principal plants used for cover crops in these provinces are red clover, summer vetch, hairy vetch, rape, buckwheat, and millet. This is also the practice followed to a large extent in British Columbia. In the irrigated districts, however, it has been found more advantageous to cultivate very little. Hairy vetch is grown as a cover crop. This is allowed to ripen seed, and then when the seed is ripe in August the soil is thoroughly disked, thus cutting up the plants and re-seeding at the same time. Alfalfa, also, has been used as a sod mulch in irrigated orchards, but has not proved as satisfactory as the vetch. In the colder parts of Canada the most satisfactory results are obtained by merely ploughing the ground in the spring, harrowing a few times to get the weeds under control, and then seeding in the month of June for a cover crop. In these colder climates it is very important to have the wood well ripened before winter, hence the importance of ceasing cultivation early.

Grapes, as has been stated, are grown mainly in the Province of Ontario. The vines are usually planted 10×10 feet apart, and are tied to a trellis of two or three wires. Where the winter is cold but the summers warm enough to ripen grapes, as is the case in many places in Canada, they are grown for home use by covering the vines with soil in winter.

Strawberries are grown almost altogether in the matted row system in eastern Canada, the plants being six inches or less apart, and a fruiting row two feet or more in width being formed, by which method the plants protect one another and are less likely to be heaved when the ground freezes and the crown is not exposed so much to the sun. In the milder and coastal regions of British Columbia the strawberry is grown on the hill system, as in England.

A large proportion of Canadian fruit growers spray their fruit plantations for the control of insects and fungous diseases as thorough spraying is necessary to ensure fruit free from injury. The principal insecticide used for biting insects is arsenate of lead, although arsenate of lime is now used to a large extent also. These have taken the place of Paris green to a very large extent. A lime-sulphur spray is mainly

FIG. 45. A FRUIT GARDEN ON THE PRAIRIES OF ALBERTA

used for San José scale and for most of the diseases of fruit that can be controlled by spraying. The lime-sulphur and other dusts have given good results in some districts, but are not generally recommended to take the place of the liquid spray. Various tobacco extracts are among the best sprays for sucking insects.

Markets and Marketing.—While there is a large amount of fruit exported from Canada, as shown by the tables, yet the amount consumed in the Dominion is very great. There are many small orchards and small fruit plantations where there is just enough grown for home consumption. The distribution of the fresh fruit in Canada is being improved each year, and when this is perfected the amount of fruit used in the Dominion should be much increased. Moreover, the population is increasing, and there are almost unlimited areas awaiting occupation by settlers. In the prairie provinces it is more difficult to grow the tree fruits than elsewhere, hence it is here that there is one of the

best home markets. Outside of Canada, Great Britain is the best market at present, but there are great possibilities in European and other countries, which, no doubt, will be taken advantage of more and more in the future, though the trade with them may not be very great at present.

Transportation Facilities.—There are excellent transportation facilities in Canada for handling the fruit. Two great transcontinental railways with many branches can readily handle and distribute all the fruit available for many years to come, and, while the distances of transportation are very great, yet it has been shown that fruit can be sent to a market many thousands of miles from where it is grown and arrive there in prime condition. Pre-cooling and cold storage plants and refrigerator cars all have done much to solve the problem of successful transportation.

Co-operation.—While co-operation among fruit growers in Canada in the selling of their fruit is not yet developed to the extent which it is hoped it will be in the near future, there has been, and is, much co-operation in the three great fruit districts of the Annapolis and adjacent valleys of Nova Scotia, the Niagara peninsula in the Province of Ontario, and the Okanagan and adjacent districts of British Columbia. The small fruit growers also of the lower mainland of British Columbia have good co-operative organisations. Three of the largest co-operative associations are known respectively as the United Fruit Growers of Nova Scotia, Kentville, N.S., the Niagara Peninsula Growers Ltd., Grimsby, Ont., and the Associated Growers of British Columbia, Vernon, B.C.

There are several methods of organisation and management. The general manager may either be paid a salary or a percentage on the amount of produce handled. The returns may be pooled, the growers being paid according to the proportion of the different grades of fruit furnished by them, or the association may pack co-operatively, and each man's fruit sell on its merits. The purchasing of supplies, co-operatively, by the fruit growers, through these associations, is of great importance to the growers.

Canning and Drying Fruit.—There has been much development in the canned fruit industry in Canada, and this phase of the fruit business is likely to develop still more. A considerable amount of fruit has been dried, also, and it is expected, through the more modern dehydration system, that the preservation of fruit by drying will be much increased in the future.

Legislation.—The federal government, by the constitution of the Dominion of Canada, controls agricultural legislation which is interprovincial in its scope and effective throughout Canada. For

instance, the Dominion government regulates the size of packages in which fruit may be marketed; it fixes standards also for different grades of fruit; and decides on the marks which may be used on the outside of the package.

The following fruit packages have now been made standards in Canada, the dimensions of these being specified in the Fruit Act (1923), an act to regulate the sale and inspection of fruit and fruit containers, which is administered by the Fruit Branch of the Department of Agriculture, Ottawa:

Apple and pear barrels, apple and pear half-barrels, apple box, apple crate, pear and crab-apple box, peach boxes, plum or prune box, cherry boxes, four-basket crate, twenty-quart wood-veneer fruit baskets, eleven-quart wood-veneer fruit basket, six-quart wood-veneer fruit basket, and after the first day of October, 1924, all berry or currant boxes manufactured in Canada will be standardised into quart and half-quart baskets.

The name of the variety must be stamped on all closed packages of fruit and also the name and address of the packer, either under an individual name or of a firm or corporation. There must also be a mark indicating the grade of fruit within the package.

The apple may be taken as an example of how fruit must be graded when packed in closed packages. When packed in barrels apples must be one of four grades, namely, No. 1, No. 2, Domestic, or No. 3.

No. 1 which shall include only well grown hand-picked specimens of one variety, sound, of not less than medium size and of good colour for the variety, of normal shape and not less than ninety per cent. free from scab, worm-holes, bruises, and other defects, no culls, and properly packed.

No. 2 which shall include only hand-picked specimens of not less than nearly medium size and good colour for the variety, sound and not less than eighty-five per cent. free from scab, worm-holes, bruises, and other defects, no culls, and properly packed.

Domestic which shall include only hand-picked specimens of not less than medium size for the variety, sound and not less than ninety per cent. free from worm-holes (but may be slightly affected with scab and other minor defects), no culls, and properly packed.

No. 3 which shall include only hand-picked specimens, no culls, and shall be properly packed.

When packed in boxes, apples must be one of five grades, namely, "Extra Fancy", "Fancy", "C", "Combination Extra Fancy and Fancy", "Combination Fancy" and "C".

A force of inspectors is employed to enforce the above regulations, and there are severe penalties for violating the law. The fruit is inspected at the packing houses, on the markets, at the chief shipping points, and at other places.

Federal and Provincial Aid to Fruit Growers.—There are six agricultural colleges at which four or five year courses are given from which, or through the universities with which they are affiliated, the graduates receive the degree of Bachelor of the Science of Agriculture (B.S.A.). These colleges are the Ontario Agricultural College, Guelph, Ont., affiliated with the University of

Toronto; Macdonald College, Macdonald College, Quebec, affiliated with McGill University; the Institut Agricole d'Oka, La Trappe, Quebec, affiliated with Laval University; the Manitoba Agricultural College, Winnipeg, Man., affiliated with the University of Manitoba; the Agricultural College of the University of Saskatchewan, Saskatoon, Sask.; and the Agricultural College of the University of British Columbia, Vancouver, B.C.

The students receive special courses in horticulture at these colleges.

There is also the Maritime Agricultural College, Truro, N.S., where students receive a two years' course in agriculture and horticulture; a recently established agricultural school at Fredericton, N.B.; an agricultural school at Ste. Anne de la Pocatière, Quebec; and one at Olds, Alta.; at Claresholme, Alta.; and at Kemptville, Ont.

Short courses in horticulture of several weeks' duration are given at some of the colleges in addition to the regular courses.

The agricultural colleges in Canada are supported mainly by the provincial governments and by private means, but some assistance is given by the federal government.

There are 24 experimental farms and stations in Canada supported by the federal government and eight substations at which horticultural experiments are being conducted. The central farm is located at Ottawa where many experiments are in progress, the number of projects being 419. These consist mainly in methods of culture, tests of varieties, spraying, and plant breeding.

The governments of Ontario, Quebec, and British Columbia employ agricultural representatives or instructors whose duty it is to go about the country and give free information and instruction to farmers and fruit growers, and, occasionally, to give demonstrations of the best methods of orchard practice. Their duty is to help in every possible way. These representatives have their offices in certain towns, where the people may go to get information, and where they may write. These offices thus become bureaux where anyone may go with any horticultural problem. At these offices bulletins are kept on various subjects which are given free to anyone who desires them. Some of these instructors conduct short courses in horticulture especially during the winter months. In the Province of Ontario, for instance, there are 50 representatives, one for each county, and, in a number of cases, an assistant as well.

Some of the provinces, as, for instance, Nova Scotia, New Brunswick, Quebec, and British Columbia have demonstration orchards of from one to five acres for the purpose of demonstrating the best varieties and methods of culture for different parts of each province.

The provincial government furnishes the trees free, and sends a man to plant them, the owner caring for the trees according to directions for ten years or more. The provincial government, also, in some cases supplies a spray pump.

Demonstrations in packing fruit by expert packers are given from time to time under the auspices of the Dominion and provincial governments in various parts of Canada.

Aid is given the fruit grower in marketing his products by the federal government in various ways. If any co-operative company desires to erect a cold storage plant for fruit the government will pay 30 per cent. of the approved cost. Experimental cold storage or precooling plants are erected, from time to time, by the government. These may, later, be taken over by private companies. The conditions of storage on board ship, when fruit is being exported, are inspected both when the fruit is being loaded and unloaded, and government thermographs are used on board the steamers for recording the temperature. The above, and other protective measures, are administered by the Dairy and Cold Storage Branch. The Fruit Branch pays much attention to the transportation and transportation charges on fruit. There is a fruit trade commissioner in London, England, under the Department of Trade and Commerce, but in close co-operation with the Fruit Branch of the Department of Agriculture, who looks after the fruit growers' interests in Great Britain.

The Destructive Insect and Pest Act is to protect the fruit grower from the introduction and dissemination of destructive insects and plant diseases, and empowers the government to inspect horticultural plants coming from other countries into Canada, and to fumigate them at stations controlled by the federal government. It also prohibits the importation of certain kinds of plants into Canada. Every person who desires to purchase horticultural plants from another country must obtain permission from the Dominion Entomologist before they may be ordered.

There are provincial laws also whereby power is given to inspect horticultural plants within each province. This includes the inspection of nurseries and the fumigation of plants before shipment. Inspectors of the Entomological Branch and the Botanical Division of the Dominion Department of Agriculture spend much time in the orchards, seeking information in regard to injurious insects and fungous diseases and finding methods of controlling them. A number of well equipped field laboratories in different parts of Canada, manned by federal officers, serve as centres for investigation and field work and as bureaux of information.

Both the federal and provincial governments aid the fruit growers by making exhibits of fruit and other horticultural products

both in Canada and other countries in order to advertise the good quality of Canadian fruit, to demonstrate best methods of packing, and to draw the attention of the public to the best varieties of fruits and to promising new sorts. The help rendered by the Dominion and provincial governments in connexion with the Imperial Fruit Show held during the past three years at London in 1921 and 1922 and at Manchester in 1923 has been much appreciated.

Canadian Horticultural Council.—From time to time, in the past, the Dominion government called prominent representatives of the fruit industry to Ottawa from different parts of Canada in order that they might discuss their problems together and then, if desired, ask the government for such legislation or other aid to the horticultural industry as would, in their opinion, advance the interests of the horticulturist in Canada. At the last conference, which was held in February, 1922, the advisability of forming a horticultural council, which would represent the horticultural industry in its broadest sense, was discussed, and it was decided that such an organisation would be of great value. The plan was for such a council to take the place of the Dominion Fruit Conferences. The Fruit Branch prepared a draft of a constitution and by-laws, and this, with some amendments, was adopted. After the conference the Canadian Horticultural Council was organised. There are eighteen members in the council, representing the fruit growers, vegetable growers, wholesale fruit and vegetable dealers, package manufacturers, florists and gardeners, jam manufacturers, canners, nurserymen, amateur horticulturists, and seedsmen throughout Canada. There are special committees to look after certain phases of the work. Much has been done by the council since its organisation.

Through the Committee on Registration, a system of plant registration has been established in Canada, also trial gardens. The council so far has been aided by a government grant.

Fruit Growers Associations and Horticultural Societies.—There are five provincial fruit growers' associations in Canada, namely, in the provinces of Nova Scotia, New Brunswick, Quebec, Ontario, and British Columbia. There is also a horticultural association, including fruit growing, in Manitoba. In the Province of Ontario there are about 170 amateur horticultural societies in the cities, towns, and rural districts, comprising about 50,000 members. From these societies delegates are sent to the Ontario Horticultural Association, an amateur society which meets annually in Toronto. While the members of these societies have their chief interest in flowers, yet a large proportion of them are fruit growers as well. These associations and societies are supported in part by the provincial governments.

Fruit Crop Reports.—A monthly report on the condition of the fruit crop in Canada and in other countries is published by the Fruit Branch of the Dominion Department of Agriculture during the growing and shipping season. There is also a telegraphic market report, which is published twice weekly through most of the year. Press reports are also issued from time to time. The information for these reports is gathered from a large number of fruit growers throughout Canada. The provincial governments also issue reports.

Bulletins, Periodicals, Press Articles.—Many valuable reports and bulletins are published by the Dominion and provincial governments and sent free to those who ask for them, and numerous press articles are furnished the newspapers from government sources. There are also several horticultural periodicals published by private companies in Canada.

In conclusion, it may be stated that the fruit industry of Canada is a very important one. The areas where fruit can be successfully grown are very great. What is now needed is better and more general organisation of the growers, and the best system of distribution that can be worked out in order to avoid gluts both in Canada and the markets overseas. These conditions are being improved from year to year.

ECONOMIC ENTOMOLOGY IN CANADA

Arthur Gibson, Esq.
Dominion Entomologist, Ottawa

Federal Work.—The Dominion of Canada first recognised officially the value of economic entomology to agriculture in the year 1884, when the late Dr. James Fletcher was appointed to the position of Dominion Entomologist. In that year and in 1885 two reports dealing with the important injurious insects of the year were published. On the creation of the Dominion Experimental Farms in 1887 the same official was appointed Entomologist and Botanist. For a period of nearly twenty years the study of entomology occupied the best of his time and labour, and he left behind him a vast store of knowledge in the annual reports which were published, in special bulletins, and in evidence which he gave yearly before the Standing Committee on Agriculture and Colonisation of the House of Commons. He died in 1908.

In 1910 the position of Dominion Entomologist was filled by the appointment of Dr. C. Gordon Hewitt, who occupied the position from that year until his death in 1920. He developed the federal entomological service from a small division attached to the Experimental Farms to an important separate branch of the Department of Agriculture. This development is shown in the establishment of important divisions at Ottawa and field or regional laboratories in the various provinces.

Now established are the Division of Field Crop and Garden Insects (R. C. Treherne, Chief); Division of Forest Insects (J. M. Swaine, Associate Dominion Entomologist, in charge); Division of Foreign Pests Suppression (L. S. McLaine, Chief); Division of Systematic Entomology (J. H. McDunnough, Chief). In addition to these divisions, several officers are devoting special attention to investigations relating to insecticides, parasites, greenhouse insects, etc.

In addition to the divisional organisation at Ottawa the following laboratories are maintained in the various provinces:

Annapolis Royal, N.S., Insecticide Investigations, Arthur Kelsall in charge.
Fredericton, N.B., Forest Insect Investigations, J. D. Tothill in charge.
Hemmingford, Que., Fruit Insect Investigations, C. E. Petch in charge.
Aylmer, Que., Forest and Shade Tree Insect Investigations, C. B. Hutchings in charge.

Vineland, Ont., Fruit Insect Investigations, W. A. Ross in charge.
Strathroy, Ont., Field Crop Insect Investigations, H. F. Hudson in charge.
Port Stanley, Ont., Corn-borer Investigations, H. G. Crawford in charge.
St. Thomas, Ont., Corn-borer Parasite Investigations, A. B. Baird in charge.
Treesbank, Man., Field Crop Insect Investigations, Norman Criddle in charge.
Saskatoon, Sask., Field Crop Insect Investigations, K. M. King in charge.
Lethbridge, Alta., Field Crop Insect Investigations, H. L. Seamans in charge.
Banff, Alta., Mosquito Investigations, E. Hearle in charge.
Agassiz, B.C., Field Crop and Fruit Insect Investigations, R. Glendenning in charge.
Vernon, B.C., Forest Insect Investigations, Ralph Hopping in charge; Fruit Insect Investigations, E. P. Venables in charge temporarily.
Victoria, B.C., Fruit Insect Investigations, W. Downes in charge.

In addition to these laboratories, the Entomological Branch maintains inspection stations at St. John, N.B., Montreal, Que., Niagara Falls, Ont., Vancouver, B.C. At these inspection stations nursery stock and other plant products entering Canada are examined

The following brief statement will indicate the research work which is now being conducted by the Branch:

Cutworm Studies and Methods of Control—Research work in connection with the bionomics and control of these important pests is being undertaken, particularly in the prairie provinces where the Pale Western cutworm is prevalent. Important progress is being made in these investigations.

Grasshopper Investigations—These are being conducted particularly in the prairie provinces and in British Columbia. Our officers have rendered valuable assistance in devising improved poisoned baits which have been adopted by provincial organizations. The life-histories of the destructive species are being studied, and data gained on natural control factors.

The European Corn-borer—In Ontario this new pest of corn is receiving much attention. The problem is an important one, and information of value is being accumulated.

The Western Wheat-stem Sawfly—This insect has developed to an alarming extent and is requiring special attention in the prairie provinces. Our officer for Manitoba is investigating further the bionomics of the insect and is obtaining information of much value in relation to measures for control.

The Hessian Fly—Further research work in Ontario, Manitoba, and Saskatchewan is being undertaken in connexion with this insect. In the former province our investigations are indicating approximate fly-free dates for the sowing of fall wheat. In the prairie provinces we find this insect has a different life-history.

White Grubs—A knowledge of the life habits of these insects is being obtained. From studies of various forms under observation, it would appear that a short regular crop rotation will to a large extent prevent serious injury.

Alfalfa Insects—In southern Alberta, owing to the importance of the alfalfa crop, research work is being undertaken in connexion with the alfalfa thrips and other insects which attack alfalfa. The importance of this work will be realised when it is stated that investigations made in 1922 showed that 80 per cent. of the buds were destroyed by the thrips.

The Onion Maggot—This important pest of onions is receiving special research, especially in eastern Canada. Data on the habits and life-history of the insect are being obtained, which will be useful in devising better measures for control.

The Colorado Potato Beetle—Intensive studies of this insect have been made in Ontario and in the maritime provinces. Much new scientific information has been obtained.

Wireworms—Special investigations relating to these insects and their control are being undertaken in the maritime provinces, from which section of Canada many complaints of injury are received. These insects, on account of their long life-history, are difficult to study, and probably several species are involved.

The Spruce Budworm—Investigations have been made in Ontario, Quebec, and New Brunswick and a mass of scientific data has been obtained. Our surveys and sample-plot studies carried on during recent years have been of great value in this connexion. Our recommendations for control aim at the prevention of future outbreaks through the application of proper methods of forestry.

Bark-beetle Investigations—Special study of the destructive eastern spruce bark beetle in Quebec province is in progress. In the Gaspé area valuable spruce stands are affected. A similar outbreak in northern Saskatchewan was investigated in 1922. In British Columbia further research in connexion with the pine bark-beetle and the Douglas fir bark-beetle is being undertaken. In the same province similar studies are being continued of the species which attack white pine and lodgepole pine.

Forest Sample Plots—The forest sample plots which have been established in Quebec, Ontario, and New Brunswick, are providing valuable information. These trees are studied each year and in this way we are able to know with certainty which agencies affect the health of the timber and the degree to which each is injurious.

The Satin Moth—Important progress is being made in studying the life-history of this pest recently introduced into British Columbia. It is an important pest in Europe, and in British Columbia has been found attacking willows in addition to poplars. A fungous disease is also being studied which may be an important factor in control.

The Larch Sawfly—With the increase of this insect in eastern Canada, special life-history and parasite studies are in progress, particularly in the province of New Brunswick.

The Rose Chafer—In Ontario, a close investigation of the life-history and habits of this insect, so destructive to grapes, is being made.

Strawberry Insects—On Vancouver island, B.C., much study has been given to the important pests of the strawberry, particularly the strawberry root weevil. As a result better control measures are being adopted by the growers.

Insecticide Investigations—Our research insecticide entomologists are making discoveries of great importance to fruit growers and others. Improvements have been made in dust mixtures for treating orchard trees and these are being used to a large extent in the Annapolis valley, N.S. Investigations are also under way to develop a method of fumigating certain types of insects by means of nicotine vapour projected from dusting machines.

Apple Sucker Disease—In the province of Nova Scotia striking results have been obtained in introducing the apple sucker disease, *Entomophthora sphaerosperma*, into orchards infested with the apple sucker. As a result of our investigations it was discovered that the disease could be spread artificially.

Mosquito Investigations—The bionomics and control of the mosquitoes of the Rocky Mountains park are being studied in a laboratory situated at Banff, Alta. The result of the control work so far has caused much favourable comment.

The National Collection of Insects—Taxonomic research occupies the time of the officers engaged on the national collection of insects. From their studies excellent progress is being made in classifying the various orders of insects and describing numbers of species new to science, the types of which are deposited in the Entomological Branch. This collection is becoming of increasing value to economic workers, both federal and provincial. The Entomological Branch has on its staff entomologists who are widely recognised as leading specialists of such important insects as the Orthoptera (the grasshoppers); Lepidoptera (butterflies and moths); Coleoptera (beetles); Hemiptera (the true bugs); Ephemeridae (may-flies); Thysanoptera (thrips), etc.

In addition to the above scientific work which is being undertaken by the various officers of the Entomological Branch, much other original research work is being conducted on other insects of importance, such as live-stock insects, household insects, greenhouse insects, etc.

As an instance of the value of the entomological research work it is stated by the Dominion Entomologist in the Agricultural Gazette, Volume 8, No. 4, 1921, that, as a result of the federal and provincial

work in 1920, crops to the value of $40,000,000 were actually saved during that year.

Publications which have been issued by the Entomological Branch have related to the following subjects: greenhouse insects, live-stock insects, the fall webworm, apple insects, bark-beetles, cattle-infesting blackfly, strawberry root weevil, western wheat-stem sawfly, grasshoppers, cutworms, white-marked tussock moth, tent caterpillars, hessian fly, plant lice, armyworm, European corn-borer, cabbage maggot, flea beetles, chinch bug, parasites of prairie cutworms, classification of cerambycid larvae, etc.

At the present time the headquarters of the Entomological Branch occupy the fifth and sixth floors of the Birks Building, Sparks Street, Ottawa.

Provincial Work.—In addition to the federal work, a number of the provinces of Canada have established entomological services, namely, Ontario, Quebec, Nova Scotia, Manitoba, Alberta, and British Colombia. The Province of Ontario has the oldest provincial service which is at present directed by Professor L. Caesar, Provincial Entomologist and Professor of Economic Entomology at the Ontario Agricultural College.

In Nova Scotia, Dr. W. H. Brittain is the Provincial Entomologist and Professor of Entomology at the Agricultural College at Truro.

In the Province of Quebec the entomological service is under the direction of M. Georges Maheux.

In Manitoba, the entomological work at the Agricultural College, Winnipeg, is directed by Prof. A. V. Mitchener.

The University of Alberta recently established a department of entomology and Mr. E. H. Strickland was appointed professor.

In British Columbia, Mr. Max Ruhmann, stationed at Vernon, B.C., conducts provincial entomological work.

Entomology is also being taught in several of our universities and agricultural colleges and a number of students are each year specialising in entomology. At the University of Toronto a short course in forest entomology is given by Professor E. M. Walker, also, courses in entomology to graduate students. At the University of Saskatchewan, Saskatoon, Sask., a series of lectures on entomology is given by Dr. A. E. Cameron. At the University of British Columbia, entomology is also taught to some extent.

The provincial departments of entomology have published some excellent bulletins and circulars. The subjects of most importance which have been discussed are as follows:

Nova Scotia.—European apple sucker; apple maggot; green apple bug; brown-tail and gipsy moths; San José scale; spray calendars for

Nova Scotia apple orchards; reports of the Acadian Entomological Society, etc.

New Brunswick.—Brown-tail and gipsy moths; forest tent caterpillar; white-marked tussock moth; spraying for orchard trees, etc.

Quebec.—Insects attacking vegetable plants; protection of plants from insect pests; potato sprays; reports of the Quebec Society for the Protection of Plants, etc.

Ontario.—Apple maggot, San José scale, oyster-shell scale; codling moth; pea weevil; hessian fly; insects attacking vegetables; insects attacking fruit; reports of the Entomological Society of Ontario, etc.

British Columbia.—Apiculture in British Columbia; pests of cultivated plants and their remedies; the variegated cutworm; poultry lice; strawberry root weevil; pea weevil; cabbage worm; cabbage root maggot; reports of the B.C. Entomological Society, etc.

In addition to the departmental work which is being carried on in the various provinces, mention should be made of the excellent work which is being done by a number of societies in Canada, particularly the Entomological Society of Ontario; the Quebec Society for the Protection of Plants; the Natural History Society of Alberta; the British Columbia Entomological Society; the Acadian Entomological Society; and the Manitoba Natural History Society.

THE GEOLOGY AND PHYSICAL GEOGRAPHY OF CANADA

W. H. Collins, Ph.D., F.R.S.C.
Director of the Geological Survey, Canada

According to an official estimate made in 1911, the Dominion of Canada has a land area of 3,603,910 square miles, or not much less than that of all Europe. It extends from latitude 42° to far within the Arctic Circle. The Mackenzie river, which is entirely Canadian, is 2,500 miles long from its source to its mouth at the Arctic ocean. The eastward-flowing St. Lawrence is navigable by large vessels for 1,500 miles from Quebec city and drains a system of five great lakes, of which Lake Superior alone is 31,800 square miles in extent. Hudson bay, a Canadian inland sea, is 800 miles from north to south and 600 miles in width.

From a geological standpoint this great territory is divisible into six natural provinces, distinct from one another in composition, structure, and age, and separated by remarkably sharp boundaries. Since the physical appearance of the country is a result of its geological history these geological provinces are also physiographical provinces, although in the latter respect they are not all so distinct. The physiographic provinces of western Canada have the clear definition of a new coin, but in eastern Canada, which is of much older construction, the original architectural features of the continent are blurred by erosion.

In the order of antiquity of their bedrocks these natural provinces are:

1. The Canadian (or Precambrian) Shield, a huge peneplanated area of crystalline Precambrian rocks that occupies the interior of Canada and constitutes the exposed part of the ancient core of North America.

2. The St. Lawrence plains, or lowlands, a series of level agricultural plains underlain by flat-lying Palæozoic strata that border the Canadian Shield on the south. These plains are only the northern edge of a great province which extends southwestward into the Mississippi basin of the United States, and from which they are separated by the Great Lakes.

3. The Arctic archipelago, a wide border of nearly horizontal Palæozoic and some later formations on the north of the Canadian

Shield, corresponding to the St. Lawrence plains on the south. It has, however, been eroded and perhaps also faulted so as now to form a great group of islands in the Arctic ocean. The coastal plain southwest of Hudson and James bays is included here.

4. The Appalachian (or Acadian) region, a hilly or even somewhat mountainous region of greatly disturbed rock formations, comprising southeastern Quebec and the maritime provinces, which constitutes the northern end of the Appalachian Mountain system of eastern North America.

5. The Cordillera, or great mountain belt of western Canada, comprising British Columbia, part of Alberta, and Yukon.

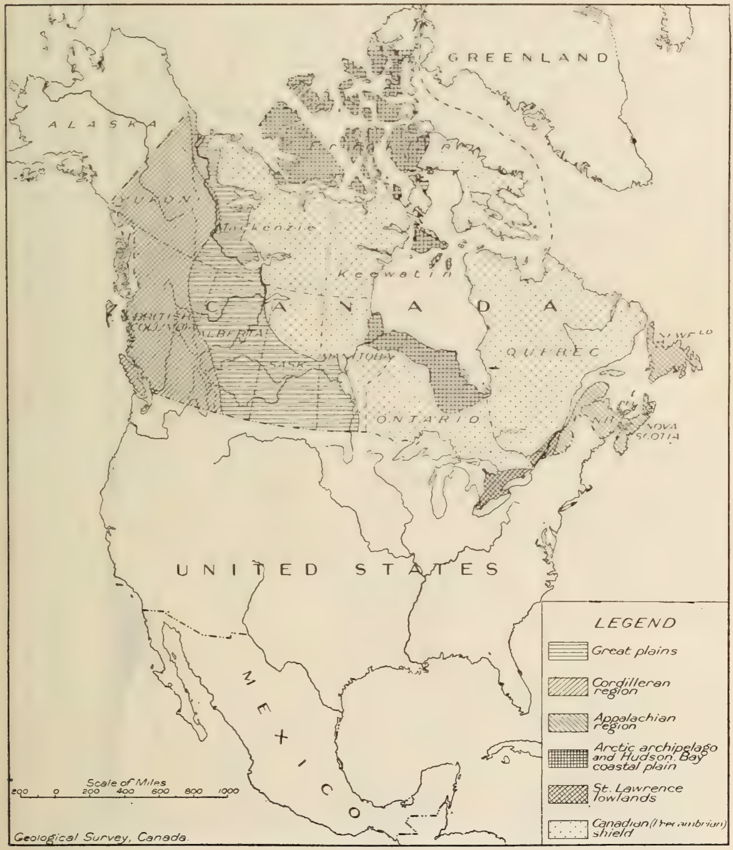

FIG. 46. PHYSIOGRAPHIC MAP OF CANADA

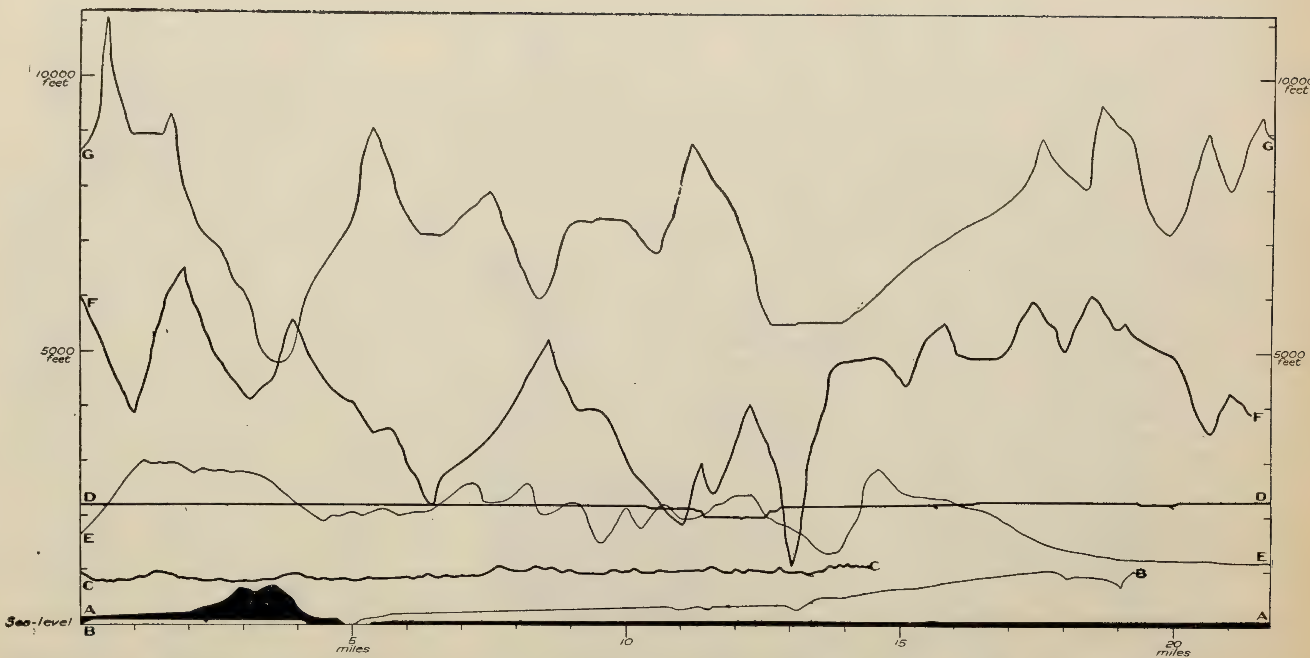

FIG. 47. TYPICAL PROFILES ILLUSTRATIVE OF THE MAIN PHYSIOGRAPHIC PROVINCES OF CANADA

A, St. Lawrence plains; B, Appalachian region; C, Canadian Shield; D, Great plains; E, Cordillera (interior plateaus, Yukon); F, Cordillera (coast range); G, Cordillera (Rocky mountains)

6. The great plains, a flat and in part treeless or prairie region underlain by nearly horizontal Tertiary, Mesozoic, and Palæozoic strata, which lies between the Cordillera and the Canadian Shield.

Canadian Shield.—The Canadian Shield (or Precambrian Shield, Laurentian plateau, or Archæan protaxis, as it is variously named) (Fig. 46), is by far the oldest of the six great structural units of which Canada is composed. It is also much the largest. The Canadian portion has an estimated area of 1,825,000 square miles, or slightly more than half of the entire country, besides which 90,000 square miles of it extend into the United States south of Lake Superior, and into New York state.

Though commonly referred to as a plateau this term is only loosely applicable. The average elevation is about 1,500 feet, but a considerable part of the Canadian Shield around Hudson bay lies between sea-level and an elevation of 1,000 feet. The Labradorean peninsula within a short distance of the Atlantic coast is decidedly mountainous and reaches, in the extreme northeast, elevations between 5,000 and 6,000 feet above sea. Nevertheless, in spite of such regional differences, there is a prevalent sameness of aspect remarkable in a region of such great extent. Characteristically it is a rugged and exceedingly rocky country of hills that do not commonly exceed 300 feet in height or differ much in elevation (Fig. 47C). The soil-sheet, consisting mainly of glacial drift, is scanty and mostly collected in the low ground, leaving the hills of Precambrian crystalline rocks bare. The scarcity and uneven distribution of soil, combined with the extreme irregularity of the rock floor, has given rise to a drainage unlike that found in any other part of Canada. A large amount of water is ponded in the inequalities of the rock floor, by barriers of glacial drift, forming innumerable ponds and lakes of the most diverse size and shape. These spill from one to another by short streams in which rapids and falls up to 100 feet in height are common. Only the larger streams, which occupy valleys of preglacial construction, have uniform channels. Seen from any commanding hill the numerous lakes, bare, rocky hills, and smooth, distant skyline are characteristic features of the Canadian Shield.

There are some parts, however, called clay belts, where the glacial drift is especially thick, or where clay and sand were deposited in shallow lakes that existed during the retreat of the Pleistocene ice-sheets. These deposits are thick enough to conceal the irregular rock floor and have formed areas resembling in miniature the great plains of western Canada, in which a normal stream drainage has developed. Such occasional areas, of which the clay belt of northern Ontario and Quebec is the largest, constitute almost the only agricultural land.

Elsewhere the mineral wealth, water-powers, and forests are the main resources of the Canadian Shield. An annual precipitation of about 30 inches, low evaporation, and the peculiar drainage combine to furnish a great number of water-powers ranging in capacity from several hundred thousand horse-power downward. Incidentally, the intricate system of streams and lakes is the natural means of travel and the canoe the universal vehicle in the Canadian Shield.

A good forest growth covers the southern part of the region, where it has not been removed by fires or by settlement. This growth, chiefly of spruce, pine, and other conifers, diminishes northward and virtually ceases beyond latitude 58° in eastern Canada, though persisting nearly to the Arctic coast in the northwest. About 40 per cent. of the Canadian Shield in Canada bears forest, and five per cent. is suitable for agriculture.

The Canadian Shield is the ancient nucleus of the continent of North America. About it and on it from Cambrian time to the present day have been spread sediments derived from its waste. Against its margin have been thrust up the Appalachian and possibly also the Cordilleran mountain systems, but the Shield itself has remained unchanged, save for gentle uplifts and subsidences and slow reduction by erosive agencies. It lies bare for 1,900,000 square miles, but there is reason to believe that it also shelves far under the surrounding terranes of horizontal strata and may underlie most of the interior of North America. A boring recently made for petroleum in the Palæozoic strata of East Tilbury township, Kent county, in southern Ontario, though 210 miles away from the Precambrian region, encountered a crystalline floor at a depth of 3,725 feet. The Precambrian basement has also been reached through 1,473 feet of Palæozoic beds west of Lake Winnipeg. The Palæozoic area southwest of Hudson bay is evidently, also, only a thin cover upon the Canadian Shield. Most of the islands in Hudson bay are Precambrian and long bands of the same rocks, bared by erosion, extend far north into the Arctic archipelago.

These Palæozoic formations which rest upon the Precambrian are nearly horizontal, and are known, from borings and other evidence, to repose upon a floor similar in form to the present surface of the Canadian Shield except for the effects of glaciation. Evidently, therefore, the Shield has undergone little change since Precambrian time. Between early Ordovician and Devonian times it oscillated considerably in elevation and was partly submerged, strata of these ages being deposited in shallow seas around it and in the vicinity of James bay. Submergence was apparently not widespread enough, however, to permit the faunas of Arctic and southern seas to mingle freely.

The only younger deposits now found on the Shield are a few patches of sand, clay, and lignite in northern Ontario, that have been identified by Keele as Cretaceous, and the widespread Pleistocene glacial drift. From Carboniferous time until the present, it seems to have been a land mass, subjected only to small changes in elevation and in coast-line, though the drowned valley of the St. Lawrence perhaps implies a considerable elevation of the land at the time it was excavated. The Pleistocene ice-sheets carried off a great quantity of rock material and characteristically modified the surface; yet they do not seem to have materially changed the main topographic features. Most of the large streams occupy valleys of preglacial construction, and even delicate preglacial details, such as dykes weathered into relief, have in places survived glaciation. According to borings through the Palæozoic in southern Ontario the buried, Precambrian surface of the shield has a gradient of 15 or 20 feet to the mile, whereas the adjoining modern surface averages only between 5 and 10 feet. This change in gradient may be a measure of the erosion since Palæozoic time, and especially of the widespread erosion during the Cretaceous, of which there is evidence in other parts of eastern America. On the other hand it may be due in greater or less degree to isostatic adjustment of the buried part of the Canadian Shield under its load of Palæozoic sediments.

At all events, the geological history of the Canadian Shield from Cambrian time forward has been placid. In utter contrast thereto is the testimony of the Precambrian rocks that compose the Shield. The stratified formations in the Shield are prevalently folded, sheared, and faulted. Associated with them are great volumes of lavas. They are cut by dykes and sills of igneous rocks, and a large share of the present surface is underlain by batholithic masses of granite-gneiss, once molten, a hundred or more miles in diameter and of unknown depth. The condition is one of suspended geological turmoil of a magnitude and violence not known to occur anywhere on the globe except in mountainous regions. The geological similarity of the Precambrian Shield is indeed so close to that found in mountain systems that it is now commonly regarded as the planated base of a vast system of mountains which were built and destroyed before Cambrian time.

Enough exploration of the Canadian Shield has been accomplished to indicate its general geological character, but only around its southern margin, particularly in the vicinity of the Great Lakes, has field work been intensive enough to reveal the sequence of geological events with approximate completeness. Even there investigation has been localised in some half dozen more or less isolated areas, and much remains to

be done in correlating the results and arranging them in historical sequence.

The later Precambrian formations are best known and seem to be most fully preserved in the Lake Superior region. There they appear to constitute one system, known as the Huronian or Algonkian, that in thickness and, probably, also in the amount of time represented, is comparable with the Palæozoic rather than with a smaller division. The succession is most completely represented in northeastern Ontario and south of Lake Superior. Its composition and the names applied there by the Canadian and United States Geological Surveys are given, for brevity, in tabular form as follows:

SUBDIVISIONS OF THE UPPER PRECAMBRIAN

Canada	United States
Huronian	Algonkian
Keweenawan: erosion remnants of conglomerate, sandstone, and volcanic flows; sills and dykes of diabase and norite; batholithic intrusions of granite (Killarney).	*Keweenawan:* a series of conglomerate, sandstone, and volcanic flows 48,000 feet thick; dykes and sills of diabase; batholithic intrusion of granite (Presquisle, etc.).
Animikie (Whitewater): a series of conglomerate, volcanic tuff, carbonaceous slate, and sandstone, 7,500 feet thick.	*Upper Huronian:* a series of conglomerate, slate, quartzite, and iron-formation, 2,000-12,000 feet thick, with associated basic lavas.
Cobalt: a series consisting basally of boulder conglomerate and other materials, probably of glacial origin, overlain by quartzite and calcareous quartzite, about 12,000 feet thick.	*Middle Huronian:* a series of conglomerate, quartzite, slate, and iron-formation, about 3,000 feet thick, with which are associated basic lavas.
Bruce: a series of conglomerates, quartzites and impure dolomitic limestone, 2,700-12,000 feet thick, resting in profound unconformity upon an older basement called the *Pre-Huronian.*	*Lower Huronian;* a series of conglomerate, impure dolomitic limestone, quartzite, and slate, about 2,500 feet thick, resting in profound unconformity upon an older basement called the *Archæan.*

The Bruce series in Ontario contains a boulder conglomerate and numerous local erosional unconformities that indicate it to be in part a land formation. The lower part of the Cobalt series (Gowganda formation) is undoubtedly a continental deposit formed under frigid climatic conditions, if not actually of glacial origin. Its upper formations (Lorrain quartzite, etc.) are well stratified, however, and apparently were deposited in water. The Upper Huronian or Animikie series is at least of near-shore origin, and the Keweenawan is a continental deposit evidently formed during a time of vigorous aggradation of a land mass of considerable topographic relief. Animikie and Keweenawan times were marked by widespread volcanic activity and intrusion of the diabasic rocks. Erosional unconformities of considerable magnitude occur between each of the four Huronian series and local erosion gaps are common in the Bruce series at least. During most of Huronian time, therefore, the Lake Superior region and prob-

ably much more of the Canadian Shield seem to have been a land mass.

Numerous oscillations in the level of this region are indicated by the erosion gaps in the Huronian system and by the alternation of terrigenous and water-formed strata. In the northern part of the Canadian Shield this relatively quiescent condition continued into the Palæozoic and up to the present day, for around Hudson bay sediments which are classed as late Precambrian (Nastapoka series, Coppermine series, etc.) are only gently folded. But south and east of Lake Superior the volcanic activity during Animikie and Keweenawan times foreshadowed an episode of violent crustal deformation of that part of the Shield which terminated Huronian sedimentation and elevated a range of mountains (Penokean or Killarnean).

The northern boundary of these mountains, as indicated by the violently disturbed Huronian formations, extended in a somewhat irregular line from Duluth to the south end of Lake Timiskaming. North of that line the Huronian strata are in open folds; south of it they become more and more closely folded, faulted, and, finally, not far from the Palæozoic border, they are invaded by granite batholiths, so characteristic of the cores of more modern mountains. How far southward this mountain-built condition continues cannot be determined on account of the overlapping Palæozoics.

There is some reason to believe that the Penokean or Killarnean mountains coincided with the southern margin of a great pre-Huronian land area, thus conforming to the arrangement of existing mountain chains. In eastern Ontario and adjoining parts of Quebec and New York state the Canadian Shield is composed of a series of crystalline limestone, quartzite, and mica gneiss (crystallised clayey and sandy rocks) known as the Grenville series. These are invaded by granitic and more basic irruptives and because of their extreme metamorphism have been regarded since Logan's time as among the most ancient Precambrian sediments. Recent field investigations near Sudbury indicate, however, that some of the granite at least is Keweenawan (Killarney) and the interesting possibility has been raised that the Grenville series, which Wilson regards as marine, may be the marine equivalent of the Bruce series, factitiously aged in appearance by the effects of Killarnean mountain-building. This possibility is given some further support by the fact that the Bruce series thickens greatly from north to south, thus suggesting the existence southward of some deep basin of deposition. If the Grenville and Bruce series are, respectively, marine and terrigenous facies of the same period of deposition, the coast-line that separated them must have lain in part in the neighbourhood of a line drawn northeastward from the northern side

of Georgian bay. The northern border of Killarnean crustal deformation, which extends nearly east and west, lies about parallel to this supposed coast-line and less than 50 miles north of it.

In northeastern Ontario and also, according to Leith, south of Lake Superior, the Huronian or Algonkian appears to have been an era of comparatively mild diastrophism between two mountain-building episodes (Penokean or Killarnean and pre-Huronian). For that reason it is regarded as a single major division of Precambrian time. In northwestern Ontario, however, a great structural unconformity which Lawson calls the Eparchean interval separates the nearly horizontal Animikie and Keweenawan from a greatly folded Huronian division consisting of two series of sediments (Steeprock and Seine series) which he believes to correspond to the lower series of the Huronian. Reconciliation of these two apparently opposed concepts constitutes one of the major geological problems of the Canadian Shield.

The Penokean or Killarnean mountains that were built towards the close of Huronian time were worn down before the Ordovician. A vestige of them persists along the north shore of Lake Huron in the picturesque Lacloche hills, which rise 400 to 800 feet above the adjoining country. A few other peaks protrude through the Palæozoics on Manitoulin island, and bore-holes that have been drilled near by in search of petroleum indicate a submountainous local relief of more than 800 feet in the Precambrian floor.

North of the region of Killarnean or Penokean mountain-building the Huronian formations repose in open folds upon a basement of still more ancient rocks called the Archæan, or pre-Huronian. Enough of the original surface of this pre-Huronian basement is preserved under a thin Huronian cover to show that when the first Huronian sediments were laid down it was a gently uneven expanse of crystalline rocks remarkably like the Canadian Shield of to-day or like that upon which the first Palæozoics were deposited. In the rocks of that remote time there are also the same evidences of mountain-building—folded, faulted, and schistified formations invaded by batholiths of granite-gneiss. To the best of geological diagnosis the Archæan or pre-Huronian is the peneplanated base of a system of mountains which were reared and base-levelled before the Bruce or Lower Huronian series commenced to form.

So deep did erosion go, even in pre-Huronian time, that individual granitic batholiths (called Algoman by some, Laurentian by others) were bared for a hundred miles or more in diameter and only a small part was left of the crustal formations into which they were irrupted. Nevertheless, enough of this crust remains, greatly changed as it is,

to disclose the general conditions which existed during the early Precambrian. Apparently it was a time of prolonged, widespread, and fairly continuous volcanic activity in the whole southern part of the Canadian Shield, during which lavas tens of thousands of feet thick were ejected. With these Keewatin lavas are associated conglomerates, greywackes, and other clastic sediments. These are found at many horizons in the Keewatin and are mostly of no great thickness or extent. A few attain thicknesses of several thousand feet, have lengths of 50 or 100 miles, and are sufficiently important to be given special names, such as Couchiching, Doré, Missi, Sudbury, Timiskaming, etc. However, there is not yet enough ground for regarding these as essentially different from the smaller formations in their relations to the Keewatin except perhaps in the case of the Timiskaming series, which is described as resting unconformably upon the Keewatin. They are all rather coarse clastic materials, varying rapidly in thickness and composition, and are apparently continental deposits. The whole association of volcanics and sediments appears to have been formed when the Canadian Shield, or at least its southern part, was a land area of considerable, if not mountainous, relief, and the seat of great volcanic activity.

The limits of this early Precambrian land and of the crustal deformation which it suffered before the Huronian are not known, but were of great extent. Just as the Killarnean mountain-building demolished the pre-Huronian basement near Lake Huron and south of Lake Superior, so the more ancient pre-Huronian mountain-building no doubt obliterated any still older geological record within its reach. The conglomerates of the Timiskaming and Doré series carry great quantities of granite boulders which must have come from older granite masses, possibly deep-seated batholithic intrusives that were laid bare by erosion. The source of these granite boulders was not known, however, until 1920 when an apparently large body of granite was found directly underlying the Doré conglomerate in Michipicoten district, on the north shore of Lake Superior. At this place the granite has supplied a vast quantity of boulders and angular blocks to the Doré conglomerate.

Is this granite evidence of a third great cycle of sedimentation, mountain-building, and planation anterior to the Huronian and pre-Huronian cycles? It is doubtful whether enough evidence has escaped these previous cycles in the Lake Superior region to answer the question, but perhaps in the vast northern part of the Canadian Shield there will yet be found the record of this and yet earlier chapters of earth history.

Broadly speaking the minerals useful to mankind are concentrated into ore deposits either by the mild processes active on the earth's surface—solution, precipitation, flowing water, organic growth, etc., or by the more intense thermal energies resident within the earth's crust. The one gives rise mainly to non-metallic deposits—coal, petroleum, salt, iron ores, etc.—characteristic of the great regions of sedimentary strata. The other is mainly responsible for the metals—gold, silver, nickel, zinc, mercury, etc.—and its effects are revealed almost solely in mountain-built regions. So, in Canada, the Cordillera, the Appalachians, and the Canadian Shield are the great storehouses of the metallic ore deposits. In the Canadian Shield the granitic intrusions of various ages have brought valuable deposits of gold and copper. The basic intrusives of Keweenawan time have given rise to the silver deposits of Cobalt and Silver islet, the nickel-copper ores of Sudbury, deposits of native copper and sulphides around Lake Superior and Coppermine river, and some gold ore deposits of minor importance. Corundum, mica, graphite, apatite, pyrite, molybdenite, and iron ore, are among many other products of the Canadian Shield.

St. Lawrence Plains.—After the last Precambrian mountains in the Canadian Shield had been reduced to hills, and the remainder of the Shield was more perfectly levelled, it was extensively, though not completely, submerged, from late Cambrian until Devonian or Carboniferous times. Shallow seas advanced and retreated around the Shield and deposited on its wide, shelving margin several thousand feet of limestones, shales, and sandstones. Along the Labrador coast the shelf is supposed to have faulted beneath the Atlantic, carrying with it all the superimposed Palæozoic. On all other sides the Palæozoics remain as they were laid down save for erosion and some normal faulting and gentle folding. They form the foundations for the Arctic archipelago, the great plains, and the St. Lawrence plains.

The St. Lawrence plains or lowlands (Fig. 46) are level, agricultural plains lying between the latitudes of Rome and Vienna, and favoured by proximity to the great river system from which they derive their name. Though only 36,000 square miles in extent they contain 60 per cent. of the population of Canada. They comprise three plains which extend at successively higher elevations from Quebec city westward to Lake Huron, for 600 miles. The first, a low plain rising from less than 100 to 200 or 300 feet in elevation and 11,400 square miles in area, extends along the St. Lawrence from Quebec city to Brockville, Ontario, and up the Ottawa valley to Pembroke. This St. Lawrence lowland is an almost perfectly level agricultural plain, rather strikingly framed in by the Canadian Shield which bounds it on the northwest and the Appalachian highlands to the southeast. The only variants

in its fertile smoothness are a few protruding peaks in the underlying Precambrian floor, such as Rigaud mountain, and also eight isolated hills of igneous rock, the Monteregian hills, which rise ruggedly and with surprising abruptness from 600 to 1,200 feet above the plain (Fig. 47 A). Between Brockville and Kingston a low arch of the Precambrian, that was apparently raised since Palæozoic time, extends southward into the United States and separates the St. Lawrence lowland from a second plain known as the Ontario lowland. The Ontario lowland, of 9,700 square miles, lies between the Precambrian area and Lake Ontario, rising gradually from 250 feet to 1,000 feet above sea. On the west the Ontario lowland ends abruptly against the rocky Niagara escarpment, 250 to 300 feet high, which crosses Niagara river from the United States and extends in a fairly straight line to Georgian bay and along the north side of Manitoulin island. Niagara river falls over this escarpment, in which it has worn a recess seven miles long. Hamilton mountain is also part of it. The triangular area of 14,200 square miles enclosed by the escarpment and Lakes Huron and Erie constitutes the Ontario upland, which ranges in elevation from 500 to 1,700 feet.

In all three divisions of the St. Lawrence plains the Palæozoic bedrock is responsible for their plain-like character, but the topographic details are mainly developed in a heavy mantle of glacial drift. The surface of the drift in the Ontario upland and Ontario lowland is more rolling than in the St. Lawrence lowland, where much of the drift is overlain by sand and clay laid down evenly in a post-glacial estuary of the St. Lawrence that extended inland to Kingston.

The geology of the Palæozoic rocks underlying the St. Lawrence lowlands is comparatively simple. From late Cambrian until the Devonian or Carboniferous, shallow seas advanced on the Canadian Shield and receded. In them were deposited sands, muds, and marls in scanty amounts from the already low Shield. These strata have since been warped gently, though sufficiently to create structures in which oil and natural gas have collected in commercially useful quantities. Some normal faults, of which the greatest has a throw of 1,850 feet, have also developed. Otherwise, they shelve regularly and at an imperceptibly low angle away from the Canadian Shield, increasing in aggregate thickness to about 4,000 feet. The sequence and nomenclature used are as follows:

Devonian	
Chemung (Port Lambton)	shale, sandstone
Genesee (Huron)	shale
Hamilton	limestone, shale
Delaware	mostly limestone
Onondaga	mostly limestone
Oriskany	sandstone
Detroit River	wind-blown sandstone, dolomite

Silurian	
Cayuga	shale, dolomite, gypsum, salt (Salina), dolomite
Guelph	dolomite
Lockport	dolomite
Rochester	shale
Clinton	shale, dolomite
Medina-Cataract	sandstone, dolomite
Ordovician	
Richmond	sandstone, shale
Lorraine (*Dundas*)	sandstone, shale
Utica	shale
Collingwood	shale
Trenton	limestone
Black River	limestone, shale
Chazy	shale, sandstone, limestone
Beekmantown	shale, sandstone, limestone, dolomite
Cambrian	
Potsdam	sandstone, conglomerate

Petroleum is obtained chiefly from the Onondaga, but also from lower horizons, even recently from the Trenton. Natural gas is found chiefly in the Silurian. Salt and gypsum are derived from the Salina formation at the top of the Silurian; and shale for brickmaking, building stone, and limestone are also products of commercial value.

The Monteregian hills are the sole evidences of igneous activity. Eight of these hills, each circular or oval in outline, from one-half to 30 square miles in area, rise from 600 to 1,275 feet above the St. Lawrence lowland. Each is composed of an association of alkaline rocks ranging from nepheline syenite to theralite. Six of them, commencing with Mount Royal at Montreal, are disposed at intervals of 5 to 15 miles in a fairly straight line eastward for 50 miles; the other two lie six miles and two miles south of this line. They are conical bodies, related to one another, and apparently represent a series of conduits that may have led to the old land surface at intervals along a plane of crustal weakness. They contain inclusions of Devonian rocks and are believed to be of about Devonian age, possibly related to the Devonian igneous activity in the neighbouring Appalachian region, though not lithologically like the Devonian granites.

These igneous hills were irrupted into a cover of other rocks and became residual eminences only as the less resistant sediments were eroded from over and around them. Evidently, therefore, a thickness of strata at least equal to the highest of these hills, and probably over 2,000 feet, has since been removed. Palæozoic strata must once have extended much farther upon the Canadian Shield than now, for isolated areas of these rocks, probably preserved from erosion by down-faulting, occur around Lake St. John and Lake Timiskaming.

Arctic Archipelago and Hudson Bay Coastal Plain.—The Palæozoics which were laid down simultaneously on the submerged southern and northern shelves of the Canadian Shield now underlie regions which contrast strangely. Whereas the St. Lawrence lowlands are fertile

and populous agricultural plains, the Arctic region is a great cluster of rugged, ice-bound islands that, together with the adjoining mainland, support less than 5,000 Eskimos, though having a land area of about 500,000 square miles. The white population of the archipelago comprises less than 100 Royal Canadian Mounted Police, Hudson Bay traders, and missionaries, and they are not self-sustaining. Furs and fish are the only useful products, but there are known to be deposits of coal and metalliferous ores which may yet be a greater source of revenue.

The Arctic archipelago is an elevated tableland, uptilted on the east side and dissected by broad depressions that are occupied by the Arctic sea. It contains over a score of islands, each of more than 500 square miles, of which Baffin island is 211,000, Ellesmere 76,600, and Victoria 74,000 square miles in extent. The interiors of these islands are almost unknown and even their coast-lines are very imperfectly charted, yet the main physical and geological features are fairly definitely determined.

In consequence of the eastern uptilt of the Canadian Shield, which continues northward from Labrador, Baffin island rises boldly on the east for 1,000 feet or more above sea, to the tableland. Toward the interior this tableland continues more gradually to rise from 2,000 to 5,000 feet, with hills rising another 1,000 feet or more. North Devon and Ellesmere islands, farther north, are about 3,000 feet in general elevation, though some peaks attain 5,000 feet. Westward the elevation diminishes to about 500 feet in Victoria island, but rises again to between 1,000 and 3,000 feet in Banks island, the westernmost of the Arctic islands.

Because of the tilted attitude of this part of the Canadian Shield, Precambrian rocks occupy much of Baffin island and extend northward into North Devon and Ellesmere islands. Another broad strip of Precambrian extends northward from Boothia peninsula. The remainder of the archipelago consists mainly of Palæozoic strata around 5,000 feet in actual thickness and overlain in places by a smaller volume of Triassic and Tertiary beds. All these are nearly horizontal, indicating that the whole region has been quiescent since Precambrian time save for uplift and subsidence and faulting.

The Palæozoic strata range from Cambrian to Carboniferous, and are composed of limestones and dolomites, shales, and sandstone. The lower part of the Carboniferous consists largely of sandstone, with important seams of coal, but the upper part contains limestones. Triassic sediments occur on Ellesmere island and in the Sverdrup islands, where they include volcanic formations. Lignite-bearing Tertiary beds occupy low-lying areas in Baffin and Ellesmere islands and elsewhere.

Apparently the course of events during Palæozoic time was much the same on opposite sides of the Canadian Shield. In the Arctic region a sea, perhaps confined to the far north during the Cambrian, advanced southward during Ordovician, Silurian, and Devonian times into Hudson bay and seems even to have reached Manitoba. This sea had begun to withdraw in the Carboniferous, and during Mesozoic and Tertiary times the Arctic region seems to have been either a land surface or but shallowly submerged.

The southern extension of the Arctic Palæozoic sea is indicated by an area of Ordovician, Silurian, and Devonian formations lying southwest of Hudson and James bays. This area is accordingly included with the Arctic archipelago, although quite different in physiographic character. A thick mantle of glacial drift, partly of marine deposition, covers the almost horizontal Palæozoic strata, forming a wide coastal plain with so little slope towards Hudson bay that it is poorly drained and swampy. Beds of gypsum occur in what is presumed to be Silurian.

Appalachian Region.—The Appalachian region of Canada includes all the territory east of a line from Lake Champlain to Quebec and south of the St. Lawrence. It occupies about 93,000 square miles. This and Newfoundland constitute the northern part of the Appalachian mountain system, which, with a width of 150 to 400 miles, extends for 1,700 miles southwestward nearly to the Gulf of Mexico.

The Appalachian mountains in Canada were first elevated in Devonian time. Since then they have undergone nearly continuous erosion combined with oscillations in elevation, which have created a land surface of moderate relief but great complexity. Many of the higher peaks in the United States rise over 6,000 feet above sea. The Canadian Appalachian region is much lower. It attains its greatest height in a rather discontinuous range which extends in a wide curve from the United States boundary northeastward towards Quebec and thence more easterly through Gaspé. The southern part, consisting of three parallel ranges known as the Notre Dame mountains, does not rise much above 2,000 feet over any considerable area and sinks much lower towards Quebec. Farther east, in Gaspé, the Shickshock mountains form a broad uplifted area from 1,000 to 3,500 feet high, in which Tabletop mountain reaches an elevation of 4,450 feet. However, in spite of this considerable altitude, Gaspé is not mountainous in aspect, but a rolling, densely wooded plateau in which the streams have carved deep V-shaped valleys.

On the northwest this axial watershed, composed of the Notre Dame and Shickshock mountains, descends rather abruptly either to the St. Lawrence lowland or to the river itself. Towards the southeast,

on the contrary, there is an irregular descent to an elevation of 150 feet along the Atlantic coast of Nova Scotia. The uplands of New Brunswick are partly plateau-like, partly more rugged, with some summits rising to 2,500 feet. Eastern New Brunswick is largely a forested rolling country seldom over 500 feet high, which is continued in Prince Edward Island and Nova Scotia. In Nova Scotia, however, the plain is interrupted by rocky highlands that rise to about 1,000 feet.

Originally the southeastward slope mentioned above is believed to have been a fairly uniform surface, or peneplain, formed by erosion not far above sea-level about Cretaceous or early Tertiary time and afterwards uplifted and tilted into its present position. At the present time, however, all that remains of this peneplain is a succession of rolling rocky highlands, miniature diminishing Gaspés, separated from one another by level, fertile lowlands several hundred feet less in elevation (Fig. 47 B). The lowlands coincide with areas of soft rock formations which were easily eroded, the highlands with harder, resistant formations, especially those that took part in the original Devonian mountain-building. In consequence, there is a general alignment of highlands and lowlands with the axis of Appalachian folding. The peculiar charm in the landscape of the maritime provinces is due in large measure to this alternation of wooded, rocky highlands and level, richly agricultural lowlands watered by winding rivers.

The Province of Prince Edward Island, popularly known asthe "Garden of the Gulf" is a lowland area, almost entirely arable, of 2,184 square miles, which nowhere rises 500 feet above the sea.

Anticosti island, in the Gulf of St. Lawrence, though immediately adjacent to Gaspé, has little in common either physiographically or geologically with the Appalachian province. It is a relatively flat island underlain by nearly horizontal Silurian and Ordovician strata and is evidently part of the wide fringe of Palæozoic formations, deposited on the shelf of the Canadian Shield, which now constitute the St. Lawrence lowlands, the Arctic archipelago, and part of the great plains.

The earliest geological record in the Appalachian region is contained in a few widely separated areas of crystalline and greatly deformed rocks which are all apparently Precambrian though not necessarily of the same age. A considerable share of Cape Breton island is occupied by granite, gneiss, and altered volcanics. Gneiss, quartzite, crystalline limestone, and volcanics occur near St. John, New Brunswick. Areas of granitic intrusives, volcanic schists, and obscure sediments are known in northern New Brunswick and Gaspé and basic volcanic schists occur in the Eastern Townships of Quebec. These are the only visible parts of what may have once been a continuous continental mass.

Whether this mass was part of the immediately adjacent Canadian Shield or formed a separate land mass is almost wholly conjectural. A neighbouring Precambrian land of considerable size, however, must have supplied the series of sands and muds, nearly five miles in thickness, which appear to be the next oldest rocks in the Appalachian region. This Gold-bearing or Meguma series of Nova Scotia has been found by Faribault and other geologists to consist of a great thickness of micaceous sandstone or whin (Goldenville series), overlain by from 5,000 to 10,000 feet of green and black slates (Halifax) and an upper Gaspereau quartzite. It contains only a few obscure markings which may represent life and its age has been variously placed between the Precambrian and Silurian. The prevailing opinion, however, is that it corresponds to the Avalon series of Newfoundland, which is overlain unconformably by the Lower Cambrian. The Gold-bearing series appears to be more closely connected with the Palæozoic formations, lithologically and perhaps also in time, than with the older Precambrian formations, and is perhaps to be regarded as representing the commencement of a period of sedimentation which continued with some interruptions up to the end of the Devonian.

The Cambrian system is represented by shales, slates, and sandstones of Upper Cambrian age in Cape Breton island and near St. John. Cambrian strata also extend in Quebec from the end of Gaspé peninsula to Vermont. In the maritime provinces these strata contain an abundant fauna more closely allied to the Cambrian faunas of northern Europe and Newfoundland than to those found in Quebec. There is also a wide difference between the Ordovician limestones of the St. Lawrence lowland and the clastic sediments of the Quebec group just across the Champlain fault which separates the St. Lawrence lowland from the Appalachian region. These differences, long a source of perplexity to Logan and his contemporaries, are now believed by some geologists to signify the existence in Cambrian and Ordovician times of two land areas, one in the Appalachian region, the other in the Canadian Shield, between which lay a long sound that extended from beyond Gaspé, through eastern Quebec into the United States. This sound, which was presumably separated from the eastern sea by the Appalachian land mass, is thought to have contained a distinct fauna, and to have received gravel, sand, and mud from the presumably high Appalachian land on one side and finer detritus from the low Canadian Shield on the other side.

Sedimentation continued through Ordovician, Silurian, and most of Devonian time, but the materials deposited bear testimony that the Appalachian region, under the load of Cambrian and gold-bearing sediments, had developed a condition of crustal instability which pre-

saged and culminated in the building of the Appalachian mountains. Limestones, characteristic of marine conditions, occur in the Ordovician, Silurian, and Devonian, but are associated with large volumes of shales, sandstones, and conglomerates. Abundant plant remains and even thin seams of coal in the Devonian near the eastern extremity of Gaspé, disturbed Devonian measures at Scaumanac near the head of Chaleur bay that are famous for their fish remains, bedded iron ores in the Silurian and Devonian of Nova Scotia and New Brunswick, and a general variability from place to place in the stratigraphic sequence, all testify to shifting physiographic conditions. An important structural unconformity between the Lower Devonian and Ordovician strata in Gaspé is interpreted as the result of folding movements, elevation, and erosion which affected the whole Appalachian region towards the close of the Ordovician. Contemporary lava formations indicate intermittent volcanic activity throughout Ordovician, Silurian, and Devonian times.

There is widespread and characteristic evidence that the whole region was vigorously mountain-built in late Devonian time. All the Devonian and older strata are greatly folded and faulted along the axis of the present Appalachian system. They are intruded and metamorphosed by batholithic masses of granite which occupy a large part of Nova Scotia, and are found diminishingly in New Brunswick, Gaspé, and the Eastern Townships of Quebec. Orotectic movements of decreasing violence continued in the United States until the close of the Palæozoic, but in Canada, except for local folding and faulting of the Carboniferous strata, they seem to have been nearly exhausted by early Carboniferous time. The eastward extent of the mountain system is unknown in Canada, being concealed by the Atlantic, but the western boundary against the Canadian Shield and the St. Lawrence lowlands is sharply defined by the Champlain fault, which extends from Lake Champlain to Quebec and thence, apparently, down the St. Lawrence river, passing south of Anticosti island.

With Devonian mountain-building the Appalachian region became an elevated land area. That part lying in Quebec has remained a land area until now, except for a brief incursion of the sea up the St. Lawrence as the Pleistocene ice-sheet retreated. The part facing the Atlantic and comprising the maritime provinces has had a very different history. By Carboniferous time it had been reduced by erosion to a region of moderate relief, nearly at sea-level, in which were exposed large areas of the deep-seated granite batholiths. Upon this surface was deposited during Carboniferous, and perhaps Permian, times an immense volume of gravels, sands, and muds with which are associated many beds of coal. The famous Joggins section of the Carboniferous is

14,570 feet thick. Besides occupying 10,000 square miles in New Brunswick, an important share of Nova Scotia, and all of Prince Edward Island they are believed to extend under the Gulf of St. Lawrence beyond the Magdalen islands. Bays and valleys of the ancient land on which these measures collected are still strikingly shown along the western side of Cape Breton island, where the Carboniferous strata fringe the highlands of crystalline Precambrian rocks.

The lowermost Carboniferous strata contain limestone (Windsor series) with which are associated widespread deposits of gypsum and salt indicative of shallow seas that became enclosed and evaporated. Above these is a great series of conglomerates, sandstones, and shales, highly variable in thickness but attaining 13,000 feet at Sydney, which contain the coal deposits of the maritime provinces. Besides the coal beds, the remains of land reptiles and numerous unconformities point to deposition on a land surface nearly at sea-level, characterised by marshes, estuaries, and tidal flats. Overlying the Coal Measures, either without noticeable disconformity or with a basal conglomerate, is a great thickness of reddish brown sandstone that underlies all of Prince Edward Island. These formations, though horizontal or only gently folded for the most part, are to a minor extent considerably folded and faulted, presumably by the mild distal effects of quite intense compressive movements which occurred in the United States part of the Appalachians.

To the Carboniferous, Nova Scotia and New Brunswick owe their great wealth in bituminous coal, oil-shale, gypsum, and salt. Their metalliferous ore deposits, especially of gold, are principally connected with the intrusions of granite that accompanied Devonian mountain-building. The great asbestos deposits of Quebec, however, as well as lesser occurrences of copper, are related to earlier igneous intrusions of Ordovician and Silurian times premonitory of mountain-building.

Some red sandstone and shale, probably estuarine or tidal-flat deposits, were formed in Annapolis valley and elsewhere around the Bay of Fundy during the Triassic, but except for these the maritime provinces seem to have permanently withdrawn from the sea at the end of the Palæozoic. The basic lava forming North mountain was also erupted at this time. Thenceforward there is almost no depositional record, but the geological history of the maritime provinces as interpreted from its physiography appears to comprise only gentle epeirogenic uplift and subsidence and continuous erosion of a land mass. By Cretaceous time, according to Daly, erosion had developed a peneplain near sea-level. A tilted uplift of this peneplain in early Tertiary time, followed by differential erosion of its soft (Carboniferous and later) and hard (pre-Carboniferous) rocks into a series of lowlands

and highlands, accounts largely for the present topography. Finally, in Pleistocene time a continental ice-sheet covered all but the central part of Gaspé, and on its retreat left the Appalachian region meagrely drift-clad and somewhat depressed beneath the sea, as shown by the marine Leda clay and Saxicava sand of the St. Lawrence lowland and the still drowned valleys that enter the Bay of Fundy.

Cordilleran Region.—Buttressing the western side of North America is a system of mountains far more extensive and imposing than their Appalachian counterpart on the Atlantic side. This Cordilleran system extends, with a width of 400 to 1,100 miles, from the extreme northwest corner of Alaska to the Isthmus of Panama (Fig. 46), a distance of 4,300 miles. In Canada alone it occupies 620,000 square miles. The Appalachians had been raised to their full height and were in an advanced stage of demolition before the present Cordilleran ranges had come into existence. The crustal movements which created the latter have also continued at intervals until recent geological times, if they are not still active. Consequently the Cordilleran mountains are loftier and more rugged than the Appalachians; and their streams, loaded with sediment, flow rapidly down steep gradients to the Pacific or out upon the great plains.

The Cordillera in Canada is made up of two nearly parallel major mountain systems separated by a linear belt of lower mountains and rugged plateaus. From east to west these divisions are known as the Rocky mountain system, the Interior belt of plateaus, and the Coast mountain system. There is a gradual change from one to another owing to the fact that the Interior belt has participated in the earth movements that raised the mountains on either side. Nevertheless, the characteristic landscapes of each are easily distinguished (Fig. 47, E, F, G).

The Rockies begin south of the international boundary and extend almost to the Arctic ocean, not continuously but in a series of overlapping ranges, which become progressively wider and lower. From the United States to the Canadian National Railway crossing, the Rocky mountains are only 50 to 100 miles wide, but many of their peaks rise between 10,000 and 12,000 feet. Mount Robson, visible from the Canadian National railway, is 13,068 feet high. North of Liard river the Mackenzie mountains overlap the Rockies on the east and thence northward they occupy a territory, 300 miles wide and almost unknown, that stretches northward and westward between the Yukon and Mackenzie rivers. A second overlapping range called the Franklin mountains lies east of Mackenzie river. The Mackenzie mountains are probably not over 7,000 feet high and the Franklin not over 5,000. Both descend to a wide plain that borders the Arctic

ocean. On the east, all these mountains descend through a belt of foothills 10 to 12 miles wide into the great plains. On the west, for most of their length they are separated sharply from the Interior plateaus by the Rocky Mountain trench, an extraordinary, linear valley from one-half to 20 miles wide, which extends without break from the United States boundary to Yukon. This great valley, though walled on both sides by steep and lofty mountains, is almost level and affords a tranquil course for the headwaters of the Kootenay, Columbia, Fraser, Peace, and Liard rivers.

The Coast system of mountains, like the Rockies, comprises several mountain ranges. Of these, the Coast range, averaging 100 miles in width, borders the Pacific ocean from the United States boundary northward for 900 miles to Skagway and, beyond, diverges inland. Though considerably older than the Rockies, and, therefore, not so rugged or high, the Coast mountains rise with enhanced grandeur directly out of the sea to elevations of 5,000 or 6,000 feet, which increase inland to 8,000 or 9,000 feet. They are now partly submerged in the Pacific. The remarkable system of fiords along the British Columbia and Alaskan coast and the multitude of islands off shore represent drowned river valleys and ridges. Outside the Coast range lies another parallel range in a still more submerged condition, of which Vancouver and Queen Charlotte islands are projecting ridges. This Insular range stands on the edge of the continent with the great depths of the Pacific beyond it. The Purcell and Selkirk mountains, which lie considerably east of the Coast range and adjacent to the Rocky mountains in southern British Columbia, though not included in the Coast system, were, according to some geologists, formed at about the same time.

Between the Coast and Rocky mountain systems lies an irregular belt from 150 to 200 miles in width and from less than 1,000 to about 5,000 feet in elevation. This belt, called the Interior Plateau region by G. M. Dawson, is broken by valleys 1,000 or 3,000 feet deep, from the bottoms of which the country appears decidedly mountainous. In reality, however, the uplands between these valleys are mostly part of a rolling plateau similar in aspect to the Canadian Shield and not much rougher. The resemblance is increased by the presence of many lakes and by the prevalent forest cover. In places, especially where Tertiary lava flows occur, the upland surface is remarkably even. In still other parts the plateau grades into rugged mountains.

The topographic diversity of the Cordilleran region is responsible for an equal diversity in other respects. There is an annual rainfall on the Pacific coast ranging from 56 inches at Vancouver to 300 inches near Prince Rupert, which diminishes to 20 or 30 inches over much of

the Interior Plateau region owing to the effect of the mountains in intercepting moisture carried from the Pacific by the prevailing westerly winds. In sheltered valleys, as at Kamloops, Okanagan, and Cranbrook, the annual fall may be less than 10 inches and irrigation required for farming and fruit-growing. Agriculture is confined to narrow river-valleys except in parts of the Interior plateau and Vancouver island, but these linear valley bottoms are commonly highly fertile. Valuable forest covers a great part of the region, the chief exception being the far northern part, the higher mountain ranges, and some of the southern valleys and plateau country which verge on aridity. Many of the last-mentioned areas are well suited for ranching and fruit-growing.

A drainage system more pronounced in pattern than in any other physiographic province of Canada and in large part closely related to the geological structure is found in the Cordillera. With some exceptions, such as the Fraser river, there are two main lines of drainage, one parallel with the mountains, the other transverse to them. By virtue of their steeper gradients and greater erosive power, as well as the ultimate necessity of all water to find egress to the Pacific ocean or to the great plains, the transverse streams have been the more powerful. As pointed out by Schofield the history of the Cordilleran stream system since the mountains were elevated, seems to have been in large part a complicated process of capture and diversion of the peaceful longitudinal rivers by smaller but more active transverse streams.

Geological investigations have been concentrated principally between the main line of the Canadian Pacific railway and the United States boundary, hence most of the following account relates to that section of the Cordillera. Enough exploration, nevertheless, has been done in northern British Columbia and Yukon to indicate that since early times the land areas and basins of sedimentation have coincided in direction with the present mountain axis. Consequently the same general assemblage of formations may be followed for great distances from southeast to northwest, whereas at right angles to the mountain ranges a changing succession of formations is crossed.

The geological record in southern British Columbia is fairly continuous from late Precambrian time to the present day. The Selkirk, Purcell, and Rocky mountains contain an old series of conglomerates, sandstones, argillites, and impure limestone, as much as 32,000 feet thick, known as the Belt series. These formations contain ripple-marks, mud cracks, casts of salt crystals, and other evidences of continental deposition, partly in shallow water. They are said to thicken and coarsen towards the west, thus implying derivation from a land

area which lay farther west in British Columbia. The confines of this ancient land are wholly unknown, but vestiges of it are probably represented in the Interior plateau by patches of gneiss, mica schist, quartzite, and crystalline limestone, called the Shuswap series. For the last fifteen years geologists have been removing from the Shuswap series rocks believed to be much younger but which had been, during Jurassic mountain-building, metamorphosed to resemble the older rocks and for that reason had been erroneously included with it; nevertheless, there are still some areas of these metamorphic rocks which appear to underlie the Palæozoics unconformably and are so much more metamorphosed that they probably antedate the Beltian. In northern British Columbia and Yukon, a widely exposed group of altered schists which are at least pre-Ordovician may be equivalent to these Precambrian rocks in the south.

The Belt series seems to have formed about the close of Precambrian time and to represent the commencement of a period of sedimentation which continued with little interruption to the end of the Palæozoic. Near Cranbrook, it is overlain, with only a slight erosional unconformity, by quartzite and a calcareous red shale containing *Olenellus*, *Cavallia*, and other Lower Cambrian fossils. Elsewhere, the plane of separation is so inconspicuous that some geologists place the base of the Cambrian well down in what others call the Belt series. With the undoubted fossiliferous Cambrian, however, the continental conditions of deposition had given place to marine conditions. Thenceforward, to the end of Carboniferous time, a sea basin appears to have existed from about the Purcell mountains eastward towards the Canadian Shield and northward beyond the Arctic coast, in which was deposited a vast thickness of limestones, shales, and sandstones formed from the waste of the ancient land to the west. It is supposed that this sea advanced and receded at times, since some of the Palæozoic deposits vary much in thickness. On the whole, however, progressive submergence is indicated by a gradual and conformable overlap of Cambrian to Devonian beds over the Beltian strata in the Purcell mountains, and throughout Carboniferous time the region was widely submerged. A Palæozoic section about 35,000 feet thick and reaching from the Lower Cambrian to the top of the Carboniferous is exposed along the Canadian Pacific railway betwen Golden and Banff. Between latitudes 58° and 62°, Palæozoic rocks extend across the cordillera, implying that a marine connexion existed there between the interior sea and the Pacific.

The record of events in western British Columbia during this interval is fragmentary. Silurian horizons have been recognised in the extreme north, in the St. Elias range. Early Palæozoic strata

have also been found on islands off the Alaskan coast. The apparent absence of early Palæozoic strata over so great an area would seem to indicate that the region west of the Rocky Mountain trench was not invaded by the sea until late in the Palæozoic era. The Carboniferous is represented by a series of argillites, quartzites, and volcanic ejectamenta with which is some limestone containing *Fusulina* and other time-marking fossils.

Judging by the general absence of marine strata and the scarcity of sediments of any kind, of Permian and early Triassic ages, in the Cordillera this interval may have been one of widespread uplift, a surmise which is also in accord with a marked increase in volcanic activity. Triassic lava deposits 10,000 to 15,000 feet thick occur near Kamloops and in Vancouver island.

This igneous activity continued into the Jurassic, foreshadowing a great process of crustal deformation which in late Jurassic time uplifted the Coast mountain system. Into the folded and faulted mountain zone was irrupted a vast core of molten granitic rocks. To-day, partly bared by erosion, these irruptives constitute the Coast Range batholith, a belt of granodiorite and allied rock types about 125 miles wide which borders the Pacific coast continuously from Yukon to the southern border of British Columbia. The bodies of similar composition which reach eastward across southern British Columbia into the Selkirk and Purcell ranges may have been intruded at the same time. From an economic point of view the construction of the Coast mountain system, together with the invasion of its granitic core, is the most important event in the geological history of the Canadian Cordillera, for from this molten core was expelled most of the gold, copper, lead, zinc, and other metalliferous wealth of British Columbia.

With the uplift of the Coast range, most of the Cordilleran region in Canada was also raised and with minor exceptions has remained to the present day a land area, subject to erosion, volcanic activity, and crustal movements. In some troughs, notably between the Coast and Insular mountains, sedimentation recommenced before the close of the Jurassic and continued over increasing areas in the Cretaceous. The sediments formed during this time are largely conglomerates, sandstones, shales, and coal beds, and prevailingly non-marine except, perhaps, along the western and eastern borders of the region. They contain a major share of the coal resources of Alberta and British Columbia. In western British Columbia they are localized mainly in the trough between the Coast and Insular ranges. East of the Coast range they are more widespread. The Fernie shale, of Jurassic age, was spread to a thickness of 1,500 feet in southwestern Alberta, to be followed more widely in the Lower Cretaceous by the coal-bearing

Kootenay group of conglomerates, sandstones, and shales, which are in places 5,000 feet thick. Jurassic and Cretaceous deposits are also found in north-central British Columbia, Yukon, and Vancouver island.

By early Eocene time a second great mountain-building process had folded, faulted, and uplifted into the Rocky mountains the great succession of Palæozoic and Mesozoic strata in the eastern part of the Cordilleran region which up to this time had remained undisturbed and almost horizontal. The compressive force, which was applied from the west, was so powerful that strata were thrust over others for as much as seven miles and it is estimated that they now occupy only half their original breadth. Compressive movements were confined largely to the Rocky, Mackenzie, and Franklin mountains, but regional uplift without folding extended westward to the Pacific and eastward over the great plains.

During and since this mountain-building period the Cordillera has undergone vigorous and continuous erosion; but, except for an area of alkali syenites at Ice river and certain other granitic bodies in south-central British Columbia, the batholithic core which may be presumed to lie within the Rockies has not yet been exposed. Some of the waste of this long period of denudation has been deposited by streams as shales, sandstones, and silts in valleys and lake basins, occasionally to depths of 5,000 feet or more and over large areas. With these freshwater deposits are found beds of lignite near Princeton, Kamloops, and elsewhere, and placer gold has been concentrated in gravel and sand deposits of the Cariboo and Klondike. Lavas were erupted during the Oligocene and Miocene to thicknesses of over 5,000 feet in places, and in less volume up to quite recent (post-Pleistocene) time. Some of the Tertiary beds have low dips indicative of gentle folding, in addition to which there is evidence along the Pacific coast of elevations and subsidences amounting to some thousands of feet.

Great Plains.—Between the Cordillera and the Canadian Shield lie the great plains, youngest of all the geological divisions of Canada, and simplest in structure. Defined here as the whole territory underlain by undisturbed Palæozoic, Mesozoic, and Tertiary strata, it is a rudely triangular region of 635,000 square miles, about 800 miles broad at the south and tapering towards the Arctic ocean. The Rocky mountains bound it quite sharply on the west, but on the east it passes almost imperceptibly into the Canadian Shield.

These plains constitute by far the largest agricultural section of Canada. About 200,000 square miles in the southern part, in which the rainfall is light, are almost or completely treeless. Northward,

although the precipitation increases little, evaporation is less and a good forest growth appears and persists almost to the Arctic coast. Wheat and oats are now being grown on a commercial scale as far north as latitude 56°.

Practically the whole plain slopes from the base of the Rockies eastward or northeastward at about five feet to the mile to the edge of the Canadian Shield. It is drained, therefore, by long rivers that flow northeastward either into Hudson bay or, by way of the Mackenzie river, to the Arctic ocean. An area of 20,000 square miles in southern Alberta and Saskatchewan lies within the basin of the Mississippi. These rivers have worn steep-sided trenches in the plain, as much as several miles in width and 300 feet deep (Fig. 47 D). Plateaus, usually not over a few hundred square miles in extent and faced by escarpments usually not over a few hundred feet high, occur at wide intervals over the southern part of the region. North of latitude 58° these remnants of an older and higher plain which has been undergoing erosion possibly since Cretaceous time, are larger, higher, and closer together. Save for these river valleys and plateaus the great plains are either level or gently undulating.

The southern part of the great plains traversed by the railway consists of three divisions, faintly dissimilar in aspect, that rise one above another from east to west by escarpments a few hundred .feet high. The easternmost division, or Manitoba lowland, comprises a level plain of 67,000 square miles and about 800 feet elevation, lying between the Canadian Shield and the plateau formed of Cretaceous strata on the west. In large part it is the old bottom of Lake Agassiz, a glacial lake now shrunken to the Winnipeg group of lakes. Portions of the Manitoba lowland that correspond to bays of Lake Agassiz extend eastward into Ontario over the Precambrian shield.

A broken line of escarpments from less than 200 to 1,000 feet high, and including Pembina mountain, Riding, Duck, Porcupine, and Pasquia hills, overlooks the Manitoba lowland and marks the commencement of a second prairie level that stands at an average height of 1,800 feet above sea but rises in places to 2,500 or 2,600 feet. This plain, of about 105,000 square miles, is diversified by low hills and the rivers are more deeply incised. Its soils are more varied than those of the Manitoba lowland and are formed almost entirely from glacial drift.

The third division, extending from the Missouri Côteau, or hilly country west of Moose Jaw, to the foothills of the Rockies, and south of latitude 54°, comprises 135,000 square miles. The surface of this plain is still more irregular than that of the last and ranges in elevation from 2,000 to 3,500 feet. Its eastern boundary, the Missouri Côteau, is a low rock escarpment, largely buried under drift, that extends northward into Canada, passing not far west of Moose Jaw.

From latitude 54° northward to Great Slave lake these divisions are no longer recognisable, partly perhaps because of the transition from a treeless prairie region to one well covered with forest and partly because the Côteau becomes inconspicuous in the north. In this part of the great plains a much larger share of the older Tertiary or Cretaceous plain is preserved in the form of extensive plateaus faced by escarpments that rise as much as 1,000 feet above the lower plain. Large areas of these "mountains" which are similar in character and origin to Duck and Porcupine mountains, and other elevations in the southern plains, occur south of Great Slave lake.

From Great Slave lake to the Arctic ocean the Mackenzie river has developed a low, heavily wooded plain 30 miles or more wide, framed on either side by the older plateau or by the ranges of the Cordillera. At its south end the Mackenzie lowland is about 550 feet above sea and descends gradually northward. The Horn and other "mountains" which rise above the lowland are flat-topped and evidently are remnants of the same older and more elevated plateau, as the Caribou mountains south of Great Slave lake, and the Cypress hills near Medicine Hat. They are, however, much more extensive and rise as much as 1,500 feet above the Mackenzie lowland.

Like the St. Lawrence lowlands and the Arctic archipelago the great plains are constituted of undisturbed and almost horizontal strata that were spread in shallow seas upon the wide, shelving margin of the Canadian Shield. But, whereas the St. Lawrence lowlands and the Arctic archipelago appear to have been formed between the low continental mass of the Shield and the open ocean, the shallow seas in which the great plains were built up were evidently bounded on the west from early times by the land mass which occupied the site of the western Cordillera. From Beltian time until the end of the Palæozoic this sea appears to have continued, spreading and contracting repeatedly and rapidly as its shallow bottom rose and fell in sympathy with the more violent crustal movements in the Appalachian and Cordilleran theatres of mountain-building. Into it were poured great volumes of sediments from the presumably high Cordilleran land in the west and scantier quantities of finer materials from the low Canadian Shield. In later Mesozoic and Tertiary times, when this sea had retreated westward and nearly disappeared, a blanket of muds and sands from the freshly elevated Cordillera was spread by streams and laid down in ephemeral seas. This blanket now conceals its foundation of Palæozoic strata, except where the latter shelve underneath it along the edge of the Canadian Shield and again along the front of the Rockies where they have been heaved up in mountain ranges.

The Palæozoic strata upturned all along the front of the Rocky mountains are about 25,000 feet thick and with local gaps range in age from Lower Cambrian to late Carboniferous or Permian. Those appearing from beneath the Cretaceous along the edge of the Canadian Shield are very much thinner and comprise only the Middle and Upper Ordovician, the Niagara and Guelph members of the Silurian, and about 2,500 feet of the Devonian, the whole succession consisting largely of limestones and dolomites, and smaller quantities of shales and sandstones. According to these sequences the Palæozoic sea occupied the western part of the great plains continuously, or nearly so, but invaded the eastern part only intermittently during Ordovician, Silurian, and Devonian times.

At the close of the Palæozoic era, when the Cordilleran region was uplifted and became a theatre of intensified volcanic activity, a large part of the great plains was also withdrawn from the sea and was not again invaded until Upper Cretaceous time. Sediments, however, were carried out from the Cordillera over the western plains during the Triassic, again in Jurassic time when the Fernie shale was deposited, and in Lower Cretaceous time when the coal-bearing group of conglomerates, sandstones, and shales was spread in places 5,000 feet thick.

Upper Cretaceous sediments were next deposited over the southern part of the region upon a nearly flat surface that varied from a little above sea-level to a little below. These sediments grow thinner and, in cases, finer towards the east and, therefore, appear to have come chiefly from the Cordilleran region. Dakota sandstones, largely if not altogether of fresh-water origin and probably spread mainly by the agency of rivers, were first deposited. In the succeeding Colorado period a shallow sea invaded the whole region of the plains and in it were laid materials ranging from 700 feet of calcareous shales along the Manitoba escarpment to several thousand feet of sandstones and shales in the west that grow coarser westward as they approach the old sea-coast. This sea shallowed during the following Montana period when shales and sandstones carrying coal beds were deposited in marine, brackish, and fresh waters. The shallowing seas of the Montana period were permanently withdrawn in the succeeding Edmonton time which terminated the Cretaceous, but deposition of muds, silts, and sands continued without apparent interruption into the Tertiary. Important beds of coal accumulated at several horizons in the Montana and both in the lower and upper parts of the Edmonton.

No structural or lithological plane of demarkation can be drawn between Mesozoic and Tertiary, and there appears to be some difference in the position of this plane according to whether the plant remains are used as a criterion, or the remains of dinosaurs, of which

many gigantic forms inhabited the great plains during Cretaceous times. The Fort Union and Paskapoo formations of Saskatchewan and Alberta are, however, placed in the Tertiary. These are capped in the Cypress hills by conglomerate and sand containing fossils of Oligocene age. The Oligocene strata are supposed to have been carried out by eastward flowing rivers from the recently uplifted Rocky mountains upon a plain that was also well elevated above sea. Probably the present flat-topped hills are only remnants of this plain left by the erosion of later Tertiary times.

Natural gas, petroleum, tar sand, and enormous quantities of lignitic coals are stored in the Cretaceous measures, and some lignite also in the Tertiary. Petroleum has recently been found in the Devonian of the Mackenzie River valley. Salt and gypsum occur in the Palæozoic strata of Manitoba and in the Mackenzie basin. Some placer gold has been carried out into the plains from the Cordillera by predecessors of the Saskatchewan river and other streams and reconcentrated to some extent by the present rivers. Igneous intrusions necessary for the production of other metalliferous deposits do not occur, however, though recently a 40-foot bed of volcanic ash has been found in the Montana series near Swift Current.

GLACIAL FEATURES OF CANADA

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Almost the whole of Canada was covered with ice-sheets in the Glacial period, only the northern part of the Yukon territory and some isolated mountain tracts in Labrador, southeastern Quebec, and Nova Scotia escaping glaciation. Canada was the half-continent most completely covered by ice in the Pleistocene, and owes to that fact the very youthful character of its hydrography and surface features. A large part of its surface has been so moulded by ice that much of its scenery suggests glaciation even to a traveller by train.

Some thousands of square miles of ice-sheet still remain on Baffin and Ellesmere lands in the far north of the arctic islands of Canada, fourteen tiny glaciers exist on the eastern side of the Torngat mountains of northeast Labrador, and many hundreds of mountain glaciers are to be seen in the Rockies, Selkirks, Gold ranges, and Coast ranges of Alberta, British Columbia, and the Yukon territory. The largest area of névé in southern Canada is the Columbia ice-field, covering nearly 150 miles and sending a dozen glaciers down into adjacent valleys. Still larger ice-sheets exist along the Alaskan boundary, such as the Llewellyn glacier, which extends from Lake Atlin to Taku inlet.

The Pleistocene glaciation of Canada took place in the main from three great centres, the Cordilleran ice sheet occupying the western mountain region, the Keewatin sheet the plains west of Hudson bay, and the Labrador or Quebec sheet the eastern part of the country. They were formed in succession from west to east, but at the times of maximum glaciation all three were in existence.

The Cordilleran sheet covered the whole of British Columbia and extended about a degree south of the boundary into the United States and a short distance north into Yukon territory. It reached Vancouver island and the Queen Charlotte islands in the Pacific and sent a few tongues through passes of the main range of the Rockies into the prairies to the northeast. The higher peaks of the mountains were not covered but projected above the ice as nunataks.

The Keewatin sheet reached the foothills of the Rockies in places but usually did not quite join the Cordilleran sheet. It extended south into the Mississippi valley, occupied part of Hudson bay, and reached

some of the arctic islands toward the north. For a long time it coalesced with the Labrador sheet and there was a contest between them, sometimes one and sometimes the other occupying the marginal territory.

The Labrador sheet covered the rest of Canada, with the exceptions mentioned before, and stretched south from the Great Lakes region to latitude 37.5° in the Mississippi valley. At one time there was a small separate ice-sheet in the district of Patricia, as shown by J. B. Tyrrell, but this was merged in the two main bodies of ice at the time of greatest extension.

The Ice age was interrupted by interglacial periods of milder climate, and in at least one of these periods the whole of the Labrador and Keewatin sheets disappeared, to return again with the oncoming of the next refrigeration.

Evidence bearing on the features just mentioned is to be seen in most parts of Canada in the form of bare, glaciated surfaces of rock, where glacial scour was effective, in boulder clay which extends over perhaps half of the country, and in the morainic ridges which were left near the margins of the ice sheets. In the mountain regions there are in addition U-shaped valleys, and at higher levels cirques, resulting from the work of greatly enlarged mountain glaciers. Along both the Atlantic and Pacific coasts there are fiords which received their final shaping by valley glaciers.

To the visitor crossing the country by train many of the features due to glaciation are quite apparent, but the most characteristic evidence of ice-work is found in the erratic blocks which are widely scattered in most regions. This is particularly true of the masses of Archaean granite, gneiss and greenstone, derived from the central parts of the Labrador and Keewatin sheets, which are now spread over the areas of Palæozoic and later sediments in southern Quebec and Ontario and on the western plains.

Going west from Winnipeg boulders of red granite stand out very distinctly on the black prairie soil, and may be seen as far as Calgary on the south and beyond Edmonton toward the north. These blocks of ancient eruptives and schists are at least 500 miles from the nearest possible source, and toward the southwest are 3,000 feet above their starting point, showing that an ice sheet can transport materials for hundreds of miles uphill, unlike running water, which must follow the gradients of the surface over which it travels.

Interglacial Periods.—Perhaps the most interesting feature of Canadian Pleistocene geology is the evidence it affords of interglacial periods of mild climate breaking the continuity of the glaciation. Such deposits are known from several localities in British Columbia, from two in Alberta, several in Manitoba, and several in Ontario. It will

be seen then that all three of the great areas of glaciation experienced these fluctuations of climate.

The most carefully studied series of interglacial deposits is that of the Toronto formation, which is well exposed in the Don valley and at Scarboro' heights near the City of Toronto. The beds were formed as a delta by a large river flowing south from the Georgian Bay region into an interglacial Lake Ontario, and at Scarboro' have a thickness of 185 feet. They contain many fossils, 120 species of animals and 42 species of flowering plants having been found in them. The plants include 34 trees, many of them of a warmer climate than the present. Palaeobotanists consider that the flora corresponds to that of Pennsylvania or Ohio at present.

The great lake was drained and mature valleys were cut in the delta; and it has been estimated that the length of the interglacial interval was at least three times as long as postglacial time, say 75,000 or 100,000 years.

Similar interglacial beds are known from river valleys on the James Bay slope 350 miles to the north; but they have not been studied in detail because of their rather inaccessible position. They include peat and brown coal with trees up to eighteen inches in diameter and are almost certainly of the same age as the Toronto formation. As they occur within 300 miles of the Labrador centre of glaciation and 500 of the Keewatin centre, it is certain that both ice-sheets had then disappeared.

In the case of the Keewatin sheet interglacial beds with plants and shells in Manitoba and Alberta are probably of the same age and confirm the conclusions drawn from the Ontario beds just described.

Glacial Lakes.—The last ice invasion, named the Wisconsin sheet by American geologists, has naturally left the strongest impress upon the country, its moraines and boulder clays having undergone comparatively little erosion in the 25,000 or 30,000 years since the ice departed from southern Ontario.

In this final retreat of the glacier the basins of the Great Lakes were gradually set free while the natural outlets toward the northeast were still blocked by ice. The lakes which thus resulted drained at first into the Mississippi, and later into the Hudson; and the present river system only came into existence at the departure of the ice.

Probably the first of these ice-dammed bodies of water was Lake Agassiz which followed up the retreating Keewatin and Labrador ice-sheets and drained into the Mississippi. At its greatest extent it had an area of 110,000 square miles, and the glacial silt deposited on its beds has furnished the flattest prairie and the richest soil of Manitoba and adjoining provinces and states. When the two great ice-sheets

separated, Nelson river began to flow and Lake Agassiz came to an end leaving Lake Winnipeg and other large lakes as its successors.

At about the same time or a little later Lake Algonquin was formed by the removal of the ice from the basins of Superior, Huron, and Michigan. This great lake, covering 100,000 square miles, had outlets simultaneously or successively past Chicago into the Mississippi, through St. Clair river and Niagara, and from Georgian bay to Lake Iroquois. Its beaches are prominent in western Ontario.

Lake Iroquois occupied the basin of Lake Ontario, but at a much higher level, since the present outlet was filled with ice for several thousand years. Its drainage was past Rome, New York, into the Hudson. The cities of Toronto and Hamilton are on its old shore, which is almost as perfect as that of the present lake, except for 80 miles at the northeast end where the ice-dam stood.

All of the old shore-lines mentioned are now deformed and rise toward the northeast or north because of the differential elevation of the land in that direction. Where the ice was thickest the load was greatest and the land was depressed to correspond. When the load was removed at the end of the Ice age the earth's crust beneath the central parts rose higher than the part more lightly burdened toward the edges.

The last of the glacial lakes was formed when the ice front withdrew beyond the Hudson Bay watershed but still covered the northern slope and James bay. It was about as large as Lake Superior but was shallow. The deposits of silt and sand in this lake have provided the "clay belt" of northern Ontario and Quebec, now being taken up by settlers and giving an easy route for the National Transcontinental railway.

The shores and deep-water deposits of the glacial lakes just mentioned, as well as some still unmapped lake-beds in western Alberta, near Calgary and Edmonton, have profoundly influenced the human history of Canada, providing sites for cities, convenient routes for roads and railways, and broad expanses of fertile soil for the farmer.

Postglacial Marine Invasions.—As the ice was melting, the most depressed parts of the region, along the Ottawa and St. Lawrence valleys and round the shores of Hudson bay, became widely flooded by marine or brackish waters, so that over much of eastern Ontario and the adjoining part of Quebec marine sands and clays were laid down, often charged with sea shells and other fossils. The Champlain sea, as the enlarged Gulf of St. Lawrence has been called, extended into the Ontario basin, whose waters remained fresh, however, and it also reached far up the Ottawa valley, including Lake Timiskaming. A broad belt around the southern shores of Hudson bay was invaded also.

These incursions of the sea were fluctuating and short lived but the clay left by its waters forms much of the good farming land of the St. Lawrence valley.

During the melting of the continental ice-sheets the level of the ocean was rising to correspond; but along with this filling up of the sea went the elevation of the unloaded land, so that the invaded regions were gradually abandoned, the outlet at the Thousand Islands rose so far as to cut off Lake Ontario, and the present conditions were inaugurated about 8,000 years ago.

Effect of Glaciation on Rivers and Lakes.—No other region of the world possesses so many lakes of all sizes and shapes as Canada, and most of these bodies of water, if not all, were caused by the hollowing of basins by ice work or the damming of valleys by drift deposits. So far as known the Great Lakes did not exist before the ice age, but their basins were parts of a great valley, that of the Laurentian river, as it has been named. It flowed from what is now Lake Superior through the present basin of Lake Huron and Georgian bay to the Ontario basin. Morainic materials filled in this channel, so that the upper Great Lakes were formed and the water was forced to take a roundabout course through Lake St. Clair and the Niagara river. On this route the water plunged over the Niagara escarpment giving rise to the famous falls.

In almost all parts of Canada we find such evidences of youth, since the new drainage systems have made but little advance in the grading of their channels. The rivers are usually not much more than spillways between lakes; and rapids and waterfalls are very numerous.

The ice age profoundly modified the hydrography of the country, breaking up what was probably a mature system of rivers and leaving behind it innumerable lakes and lakelets connected by quite accidental channels.

Ancient Glaciation in Canada.—Canada not only has the largest area of Pleistocene glaciation of any country in the world, but has also evidences of a number of earlier ice-invasions, most of them, however, on a much smaller scale. Ancient boulder clay or tillite has been found in rocks of the Eocene, the Carboniferous or Permian, the Devonian, the Ordovician, and the Huronian. The last-named glaciation occurred in the same region as that covered by the Labrador ice-sheet and may have been almost as extensive, since its boulder conglomerates have been found scattered over many thousands of square miles of the ancient Laurentian peneplain; and it is certain that only remnants of this earliest of known boulder clays still survive the vast erosion that has gone on since the Precambrian. The best preserved part of this till-sheet is to be seen at the silver mines of Cobalt, and good examples of striated stones from it are shown in the Royal Ontario Museum of Geology in Toronto.[1]

[1]For bibliography see appendix.

THE DINOSAURS OF ALBERTA

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Canadian contributions to geological science are so many and so varied that the selection of a topic of particular importance must depend on the point of view of the person making the selection. To many, however, the Cretaceous dinosaurs of Alberta make an especial appeal by reason of their great scientific value, their extraordinary profusion and diversity, and their somewhat spectacular character.

The Red Deer river rises in the Rocky mountains and flows more than 300 miles to its confluence with the South Saskatchewan river. In this long course across the prairies it has excavated a valley to a depth sometimes exceeding 400 feet. In places, this valley has banks so precipitous that it may be described as a canyon; in other places it is wider with a less abrupt descent. In the latter case the removal of the rock by erosion is incomplete with the result that steep residual hills—the so-called buttes—are left standing in the valley. These wider, butte-studded stretches are typical *badlands* which can develop only under semi-arid conditions and prevailing high winds. The most extensive area of badlands lies along the river for about 15 miles below the little village of Steveville and attains a maximum width of nearly three miles.

The strata exposed in the Red Deer valley are indicated in the following table:

Geological Formations on the Red Deer River, Alberta

<table>
<tr><th>Age</th><th>Formation</th><th>Rocks</th></tr>
<tr><td>Paleocene</td><td>Paskapoo</td><td>Freshwater sandstone and shales</td></tr>
<tr><td rowspan="3">Upper Cretaceous</td><td>Edmonton</td><td>Brackish-water sandstones and shales with coal. Dinosaurs</td></tr>
<tr><td>Bearpaw</td><td>Marine shales. No dinosaurs</td></tr>
<tr><td>Belly River</td><td>Brackish-water sandstones and shales with coal. Dinosaurs</td></tr>
</table>

As indicated above the remains of dinosaurs occur in two distinct formations, the Edmonton and the Belly River. The most prolific locality in the former lies along the river from a point about 25 miles

above Drumheller to a short distance below that town which is situated at the confluence of Rosebud creek. The wonderfully rich exposures of the Belly River formation lie farther down the river, beginning near the mouth of Berry creek and extending for about 15 miles below that point.

Dinosaur remains were first observed in the Canadian northwest by Dr. George M. Dawson in 1882, and were first reported from the Red Deer river by Mr. J. B. Tyrrell in 1887. To the Geological Survey of Canada, through the efforts of Mr. Lawrence M. Lambe, belongs the honour of the first serious collecting and the announcement of the unusual richness of the strata. With the exception of a small amount of local collecting, the expeditions into the valley of the Red Deer river have been as follows:

EXPEDITIONS INTO THE VALLEY OF THE RED DEER RIVER

Year	Institution	Officer in charge in the field
1897	Geological Survey of Canada	Lawrence M. Lambe
1898	" " " "	" " "
1901	" " " "	" " "
1909	Am. Museum of Natural History	Barnum Brown
1910	" " " " "	" "
1911	" " " " "	" "
1912	" " " " "	" "
1912	Geological Survey of Canada	Charles H. Sternberg
1913	" " " "	" " "
1914	" " " "	" " "
1915	" " " "	" " "
1916	" " " "	George Sternberg
1917	" " " "	Charles M. Sternberg
1917	....	Charles H. Sternberg
1918	University of Toronto	W. A. Parks
1919	" " "	" " "
1919	Geological Survey of Canada	Charles M. Sternberg
1920	....	George Sternberg
1920	University of Toronto	Levi Sternberg
1921	" " "	" "
1921	Geological Survey of Canada	Charles M. Sternberg
1921	University of Alberta	George Sternberg
1922	University of Toronto	Levi Sternberg
1922	Field Museum, Chicago	George Sternberg
1923	University of Toronto	G. E. Lindblad
1923	Geological Survey of Canada	Charles M. Sternberg

The average number of major specimens—complete heads or nearly complete skeletons—obtained by each of these expeditions may safely be estimated as five, making 130 in all. In addition a very great quantity of fragmentary material was obtained as well as skeletons of reptiles other than dinosaurs, particularly turtles.

All the material obtained by institutions, as far as I am aware, is still in their possession. The private collection made in 1917 by Mr. C. H. Sternberg was sold, in part, to the American Museum of Natural History and in part to the San Diego Natural History Society. A few specimens, also, were sent to Europe. The George Sternberg collection of 1920 was purchased by the University of Alberta.

It is not possible, at the present time, to present a detailed statement of the major material collected, as much of it is still in boxes awaiting the attention of the preparator. Probably the largest of the collections is in the Victoria Memorial Museum, Ottawa, with some

FIG. 48. CAMP IN BAD LANDS OF ALBERTA
Dinosaur expedition of the University of Toronto, 1921.

magnificent skeletons mounted. Through the kindness of Dr. W. D. Matthew of the American Museum of Natural History, New York, I am able to give the following summary of the more important material in that museum:

Deinodontidae
    Five species, eight specimens
Ornithominidae
    Two species, two specimens
Trachodontidae
    Two species, twenty specimens
Ceratopsia
    Four species, fifteen specimens
Nodosauridae
    Three species, ten specimens

The specimens which have been mounted to date in the Royal Ontario Museum of Palæontology, Toronto, are as follows:

Kritosaurus incurvimanus. Nearly complete skeleton
Parasaurolophus walkeri. Nearly complete skeleton
Prosaurolophus maximus. Nearly complete skeleton
Centrosaurus apertus. Complete head and part of skeleton
Corythosaurus intermedius. Two heads; part of one skeleton
Dyoplosaurus acutosquameus. Rear portion of skeleton; part of head

The collections contain, in addition, several almost complete skeletons some of which are undoubtedly new to science.

The museum of the University of Alberta contains a fine skeleton of the great carnivore, *Gorgosaurus libratus*, and a wonderfully preserved head of *Tröodon validus* besides other material.

The value to science of the Red Deer dinosaurian remains is very great. The number of species, alone, attests the extraordinary diversity attained in Cretaceous time by these remarkable animals. An extensive series of *Ceratopsia* has revealed the evolutionary history of the group. Many new genera and species of *Trachodontidae* have enabled us to trace the development of the unarmoured *Predentata*. The great carnivorous type is represented by several new genera and much has been added to our knowledge of the light, agile *Ornithominidae*.

The most remarkable of all land animals, the huge, unwieldy, plated dinosaurs, the *Nodosauridae*, lived in great numbers along the shores of the Cretaceous seas in what is now Alberta. While no really complete skeleton has yet been found, the total number of skulls, teeth, plates, and other parts is so great that the assembling of all the available information will reveal much of the developmental history of this remarkable race.[1]

[1]For bibliography see appendix.

THE MINERAL INDUSTRY OF CANADA

Wyatt Malcolm, M.A.
Geological Survey of Canada, Ottawa

The mineral industry is one of the most flourishing industries of Canada and one with a very promising future. The value of the annual mineral production reached its maximum in 1920 when it amounted to $227,859,665. In 1922 the production by provinces was as follows:

Mineral Production of Canada, 1920

Nova Scotia	$25,923,499
New Brunswick	2,263,692
Quebec	17,647,939
Ontario	65,867,183
Manitoba	2,258,942
Saskatchewan	1,255,470
Alberta	27,872,136
British Columbia	39,422,808
Yukon	1,785,573
Total for Canada	$184,297,242

Canada is of vast extent and includes within its boundaries large areas differing greatly from one another in geological conditions. As a consequence a great variety of commercially important minerals, metallic and non-metallic, is found. This in itself augurs well for the future of the industry and conduces to a freedom from wide fluctuations in total production. Adverse market conditions with respect to one mineral or series of minerals are likely to be offset by favourable market conditions with respect to other minerals, and the decline of one mining camp is compensated by the discovery and development of others. Thus, not only is an equilibrium in total production maintained but a stabilisation of conditions with respect to mine labour tends to be effected. An industry widely and deeply rooted has tremendous vitality.

The article on the geology and physical geography by Dr. W. H. Collins indicates the greatly varied nature of the existing geological conditions. Sedimentary formations of all the great geological systems, Precambrian, Palæozoic, Mesozoic, and Cainozoic, are widespread. There are large areas in which the formations lie nearly horizontal and are little altered; there are other large areas in which they have been tilted at high angles with or without regional and con-

tact metamorphism. Vast stretches of country are underlain by igneous rocks, intrusive and extrusive. In these different types of rock formation and genetically related to them occur economic minerals in great variety and abundance. In the Carboniferous formations of Nova Scotia are found the extensive bituminous coal seams and the gypsum deposits that form the backbone of the mineral industry of the province. Of Carboniferous age, also, are the bituminous coal and gypsum deposits of New Brunswick and the salt bed of Malagash, Nova Scotia.

The flat-lying Ordovician, Silurian, and Devonian limestones, dolomites, shales, and sandstones of southern Ontario are the repositories of the salt beds that have, for over half a century, formed the basis of Canada's most important salt industry; the small oil pools that have been drawn upon for sixty years; the natural gas of the counties bordering Lake Erie; and the gypsum beds of Grand River valley.

Palæozoic formations carry the gypsum deposits of Manitoba, on which an important industry has been established, and of northern Alberta; the salt beds discovered in the vicinity of McMurray; and the petroleum of Mackenzie River basin. In the Cretaceous and Tertiary formations are found the extensive lignitic, bituminous, and anthracitic coal seams of Saskatchewan, Alberta, British Columbia, and Yukon. The Cretaceous sediments also carry the natural gas and bituminous sands of Alberta.

The sedimentary formations from the Atlantic to the Pacific furnish valuable building materials, materials entering into the growing metallurgical, pulp, and chemical industries, and raw materials for the manufacture of cement and various products of clay and shale. Unconsolidated deposits of the western Cordillera carry the gold placers of Klondike and Cariboo.

Of very striking importance in connexion with the mineral industry are the large areas underlain by igneous intrusives and highly metamorphosed sediments and formations of volcanic origin. These are found mainly in the western Cordillera embracing British Columbia and Yukon, in the wide-flung subdued plateau surrounding Hudson bay and composed of rocks of Precambrian age, and in a less degree in the Appalachian area of Quebec southeast of the St. Lawrence, of New Brunswick and Nova Scotia. Here are found the rich deposits of metallic minerals most of which lie in igneous rocks or in metamorphosed sediments and have been described generally as having had their origin in igneous magmas. They include the gold veins of Nova Scotia, the asbestos of Quebec, the nickel-copper ores of Sudbury, the silver veins of Cobalt, the lode gold of Porcupine and Kirkland Lake, the Mandy and Flinflon copper deposits of Manitoba, the large copper deposits of Anyox, Britannia Beach, and Allenby mountain,

British Columbia, the gold-silver ores of Salmon River area, the silver-lead-zinc ores of British Columbia, and the silver-lead ores of Mayo, Yukon. They include also numerous non-metallic minerals of southeastern Ontario and southern Quebec, such as feldspar, talc, mica, magnesite, graphite, and kaolin.

The relative importance of these minerals commercially is indicated by the following table:

MINERAL PRODUCTION OF CANADA FOR THE YEAR ENDING DECEMBER 31, 1922

		Quantity	Value
Metallic			
Copper	Lbs.	42,879,818	$ 5,738,177
Gold	Ozs.	1,263,364	26,116,050
Lead	Lbs.	93,307,171	5,817,702
Nickel	Lbs.	17,597,123	6,158,993
Silver	Ozs.	18,581,439	12,576,758
Zinc	Lbs.	56,290,000	3,217,536
Other metallic minerals (*a*)			2,160,491
Total			$61,785,707
Non-Metallic			
Asbestos	Tons	163,706	$ 5,552,723
Coal	"	15,157,431	65,518,497
Gypsum	"	559,265	2,160,898
Natural gas	M. cu. ft.	14,682,651	5,846,501
Petroleum	Bbls.	179,068	611,176
Salt	Tons	181,794	1,628,323
Other non-metallic minerals (*b*)			1,658,676
Total			$82,976,794
Structural Materials and Clay Products			
Cement, Portland	Bbls.	6,943,972	$ 15,438,481
Clay products		....	11,438,456
Lime	Bush.	7,742,651	3,165,005
Sand and gravel	Tons	11,666,371	3,502,935
Slate		1,899	14,871
Stone	Tons	3,637,182	5,974,993
Total			$ 39,534,741
Grand Total			$184,297,242

(*a*) Cobalt, iron, palladium, platinum, rhodium, osmium, iridium, ruthenium.
(*b*) Actinolite, arsenic, barytes, chromite, feldspar, fluorspar, graphite, grindstones, magnesite, magnesium sulphate, manganese, mica, mineral water, natro-alunite, iron oxides, peat, phosphate, pyrites, quartz, sodium carbonate, sodium sulphate, talc and tripolite.

In a short article notes on only a few of the most important minerals can be given.

Coal.—Canada has an abundance of coal. Nova Scotia, Alberta, and British Columbia are the leading coal-producing provinces; less important are New Brunswick, Saskatchewan, and Yukon. One of the earliest minerals to attract attention, coal was mined in a desultory manner in Nova Scotia during the eighteenth century. It was not, however, until 1825 that operations were commenced on a systematic scale when the General Mining Association took over a lease of all the

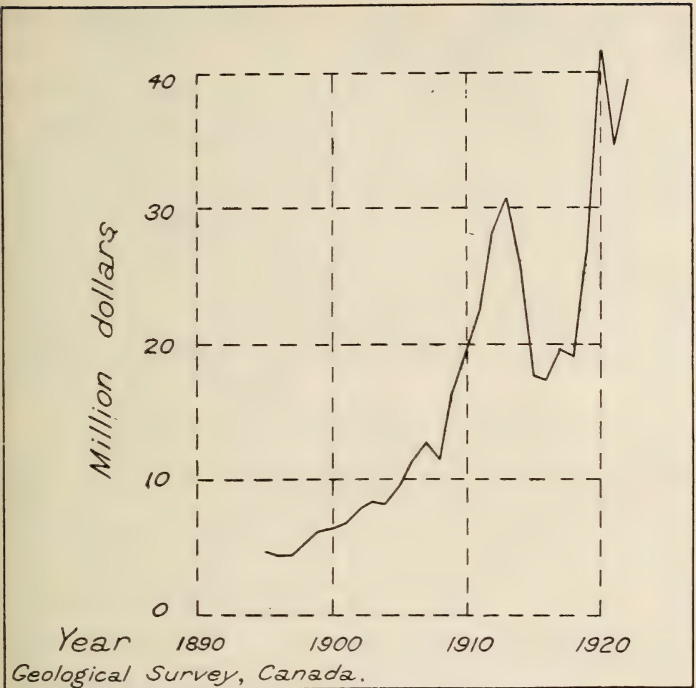

FIG. 49. PRODUCTION OF STRUCTURAL MATERIAL, CEMENT AND CLAY PRODUCTS, CANADA

Showing growth of the industry, also effects of the war.

mines and minerals of the province. Mines were opened on Vancouver island about the middle of the last century and in Alberta towards the end of the century.

During the last fifteen or twenty years coal mining in Alberta has made wonderful strides and in recent years the tonnage production of this province has surpassed that of Nova Scotia. The industry is still in an initial stage in which operations are carried on at many points by many rival companies. There is a promising future. With increase of population of the prairie provinces greater demands will arise for fuel for domestic heating, for railway transportation, and for manufactures, and attempts are now being made to build up a market for domestic fuel from Alberta in the populous centres of Ontario.

The bituminous coal of Nova Scotia and British Columbia is used for bunkering and power development, and is the basis of the extensive

metallurgical industries of these two provinces. Nova Scotia coal finds a ready market in the Province of Quebec, large shipments being made by boat up the St. Lawrence.

Asbestos.—Asbestos is the most important mineral produced in the Province of Quebec. The greater part of the world's supply is derived from the deposits of this province. The mineral occurs in veins in serpentinised peridotite. The veins are usually less than two and a half inches in width and most of them are less than one-half inch. The asbestos-bearing rock is recovered partly by open-pit quarrying and partly by underground mining. The best grades of fibre are cobbed by hand from the rock, but in the recovery of the asbestos of the smaller veins the rock is crushed and the fibre removed mechanically. The industry feels the competition of the Rhodesian long fibre and a commendable attempt has been made to consolidate competing Canadian interests and thus establish conditions more favourable to the operating companies and advantageous to the country.

The most important metallic minerals are gold, nickel, copper, silver, lead, and zinc. Ontario is the only province producing nickel, and it leads in the production of gold and silver, all three minerals being found in rocks of Precambrian age. British Columbia leads in the production of copper, lead, and zinc. A description of the gold mining industry will be given elsewhere in this publication and no doubt reference will be made to the gold-silver deposits of the Salmon River area, the placers of Yukon and Cariboo, the lodes of Porcupine and Kirkland lake, and the prospective possibilities of Quebec.

Nickel.—Canada supplies over three-quarters of the world's nickel. The ore deposits, which are found in the vicinity of Sudbury, are large bodies of irregularly lenticular form extending to unknown depth. The metallic minerals consist of a mixture and chemical combination of sulphides of nickel, copper, and iron. The fifteen years prior to the outbreak of the great war were marked by a very rapid growth in the nickel industry. A great impetus was given to the industry by the war and the production rose from 24,838 tons in 1913 to 46,254 tons in 1918. As a result surplus stocks were accumulated, which were added to by the heavy production of 1920. The depression that came towards the end of that year forced two of the producing companies to discontinue operations and the third company greatly to curtail its output. The industry, however, has resumed its pre-war activity and all three companies are mining. All have smelters in the mining district and two have refineries in Canada. Few better examples can be given of the benefits to be derived from scientific research than that of the companies interested in the sale of nickel. Investigations have been made into the properties of the pure metal

and of non-ferrous nickel alloys with the result that the application of these in the industries of peace has been extended, and new markets have been created.

Copper.—The provinces of British Columbia and Ontario are the most important copper-producing provinces, British Columbia holding the leading position. Quebec has maintained a steady and moderate production with little intermission for many years. Some high-grade copper ore was shipped a few years ago from the Mandy mine in northern Manitoba to the smelter at Trail, British Columbia. A neighbouring deposit of copper-zinc-iron sulphides, known as the Flinflon deposit, has been calculated to carry 16,000,000 tons within a depth of 900 feet. Much development work has been done on this property preparatory to carrying on mining operations when transportation facilities are available.

Ontario's copper production comes from the nickel-copper ores of Sudbury district and the quantity produced is thus dependent to a great extent on the demand for nickel. The production in British Columbia is mainly from large low-grade sulphide deposits that had their origin in the igneous magmas of the Coast Range batholith. The two most important mines are at Anyox and at Britannia Beach, both on the Pacific coast. The ores at Anyox are smelted in British Columbia and those of Britannia Beach are concentrated for shipment to outside points. A concentrator is in course of erection at Anyox for handling a large quantity of ore that is not suitable for direct treatment in the smelter. A large body of low-grade ore on Allenby mountain in southern British Columbia has been developed for mining, and a concentrator erected. Work was done on this property in 1923 preparatory to mining, and arrangements were made for treating the concentrates at Trail, but the fall in the price of copper during the latter half of the year necessitated a temporary cessation of work.

Lead and Zinc.—There is a steady production of lead and zinc in fair amount at Galetta, Ontario, and during the last three or four years a considerable quantity of highly argentiferous galena has been shipped from the Mayo district, Yukon. British Columbia is the premier province, however, in the production of lead and zinc. The Sullivan mine of the southeastern part of the province is the main producer. The ores consisting of sulphides of lead, zinc, and iron are concentrated in a mill that has but recently been completed and the concentrates are shipped to Trail for metallurgical treatment. The opening of this concentrator which carries into effect the result of long and careful investigations frees the concentrator at Trail for work upon the Rossland ores.

Silver.—The lead-zinc ores of British Columbia carry silver. In very recent years a considerable amount of silver has been produced from the gold-silver deposits of Salmon River area, British Columbia, and from the argentiferous galena of the Mayo area, Yukon. Ontario, however, continues to hold the leading position, Cobalt still being the most important silver camp of Canada. Recent developments in the South Lorrain camp, in which ores similar to those of Cobalt and of similar origin are found, have led to a revival of interest in other areas in the vicinity and a renewed search for other ore bodies. The total silver production of Cobalt since its discovery in 1903 and of the other smaller producing areas that may be considered satellitic to it exceeds 330,000,000 ounces. It reached its maximum in 1911 when it amounted to 31,507,791 ounces. In 1922 it was over 9,000,000 ounces.

Growth of Industry.—The last quarter of a century has been a period of marvellous development in the mineral industry of Canada. It is an old industry. Coal was mined in Nova Scotia in the eighteenth century; charcoal iron for local use was smelted from Canadian ores in Quebec early in the eighteenth century and in Ontario at the beginning of the nineteenth century; and the mining and smelting of iron were early industries of Nova Scotia and New Brunswick. More strictly speaking, however, mining in Canada is an industry of the twentieth century, this being the period of its greatest growth, a period during which nearly every year was marked by an increase in production. There have been very decided fluctuations in the production of certain metals such as gold and silver, owing to the rise and decline of some important mining area like Klondike and Cobalt. On the other hand a steady increase has taken place in general in the production of base metals such as copper, nickel, lead, and zinc, and in the production of clay products, structural materials, and coal. The following table of mineral production is an indication of the development of the industry:

GROWTH OF TOTAL MINERAL PRODUCTION OF CANADA

1890	$ 16,763,353
1895	20,505,917
1900	64,420,877
1905	69,078,999
1910	106,823,623
1915	137,109,171
1920	227,859,665

The growth of the mining industry was concurrent with, and in part dependent upon, a great increase in industrial activity as indicated in the graph of the total imports and exports of the country. To such

a degree do the products of the mine and quarry enter into man-made things of the present day that industrial progress creates an increasing demand for metals and other mineral products. This century has been a period of extensive railway construction, of the building of steel cars and steel ships, and of a great increase in the use of steel, cement, brick, and fireproof materials in the construction of large commercial

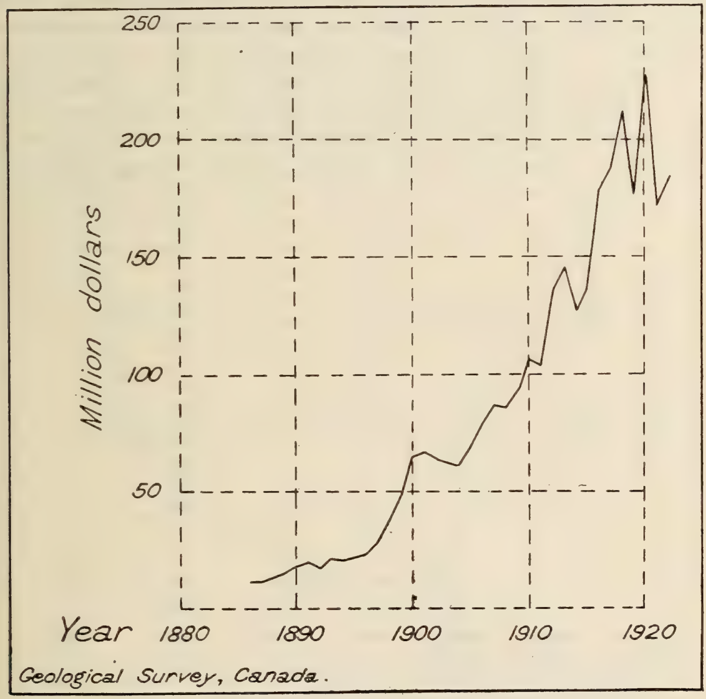

FIG. 50. TOTAL MINERAL PRODUCTION OF CANADA

and industrial buildings. It has been a period of opening of great oil fields and construction of pipe-lines; of water-power development; of development, transmission, and utilisation of electrical energy; of the establishment of the automobile industry; and of the growth of the chemical industry. All these and other activities created demands for such Canadian products as coal, copper, nickel, lead, zinc, asbestos, cement, and brick.

A most intimate relation exists between the expansion of transportation facilities and the growth of the mineral industry. The great

systems of lakes and streams have provided access to new prospecting areas and permitted of the transportation of machinery, supplies, and the products of the mine. Only a few examples need be mentioned: Fraser river led the gold seekers to the placers of the Cariboo district; Yukon river was a link in the system of transport to and from the Klondike; Mackenzie river served to carry machinery and supplies to below Norman where a flow of petroleum was struck; and the St. Lawrence gives the Nova Scotia coal ready access to the markets of Quebec.

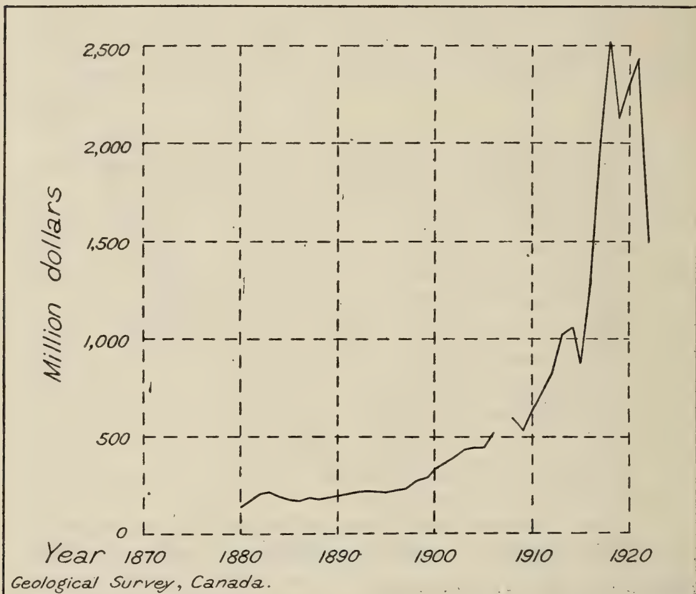

FIG. 51. TOTAL EXPORTS AND IMPORTS OF CANADA
This graph indicates industrial activity and is to be compared with that of mineral prodction.

The construction of railways has led in a remarkable way to the discovery and development of mineral deposits. The construction of the Quebec Central railway rendered possible the commercial development of the asbestos deposits; the construction of the main line of the Canadian Pacific railway led to the exploitation of the enormous deposits of nickel-copper ores of Sudbury; the silver of Cobalt which has been one of the leading silver camps of the world was discovered by men employed in construction work on the Timiskaming and

Northern Ontario railway; this railway has given ready access to areas that have proved very favourable to prospecting and as a result the gold fields of northern Ontario were discovered and the promising prospects of Quebec revealed; the construction of the Hudson Bay railway drew attention to the mineral possibilities of northern Manitoba and led to the discovery of copper and gold deposits; and the railways crossing Alberta gave access to the coal fields of the province.

The water power of Canada has proved an important factor in the development of the mining industry, and the mining and milling plants of British Columbia, Ontario, and Quebec rely to a very considerable extent on electric energy derived from the large streams.

The general abnormal conditions of the period of the great war created abnormal conditions in mining. For a short time after the outbreak of war the uncertainty of the situation led to a slackening in

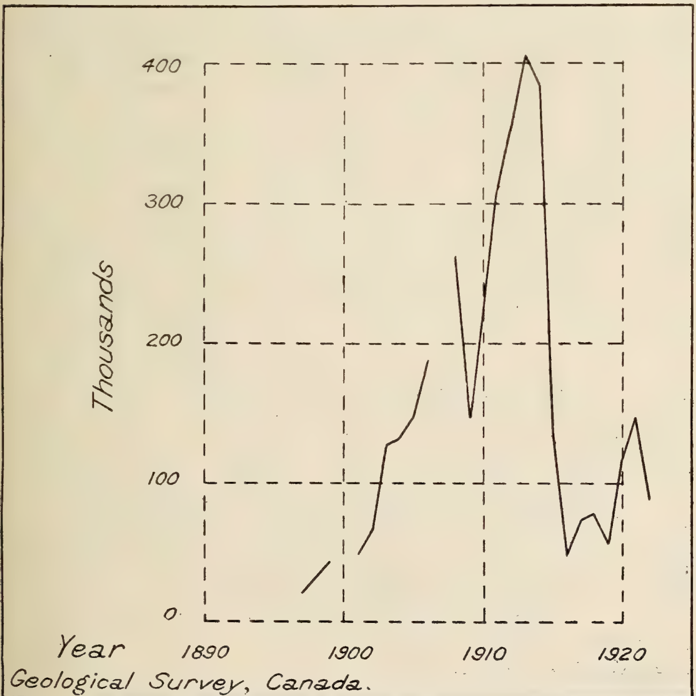

FIG. 52. NUMBER OF IMMIGRANTS ADMITTED TO CANADA

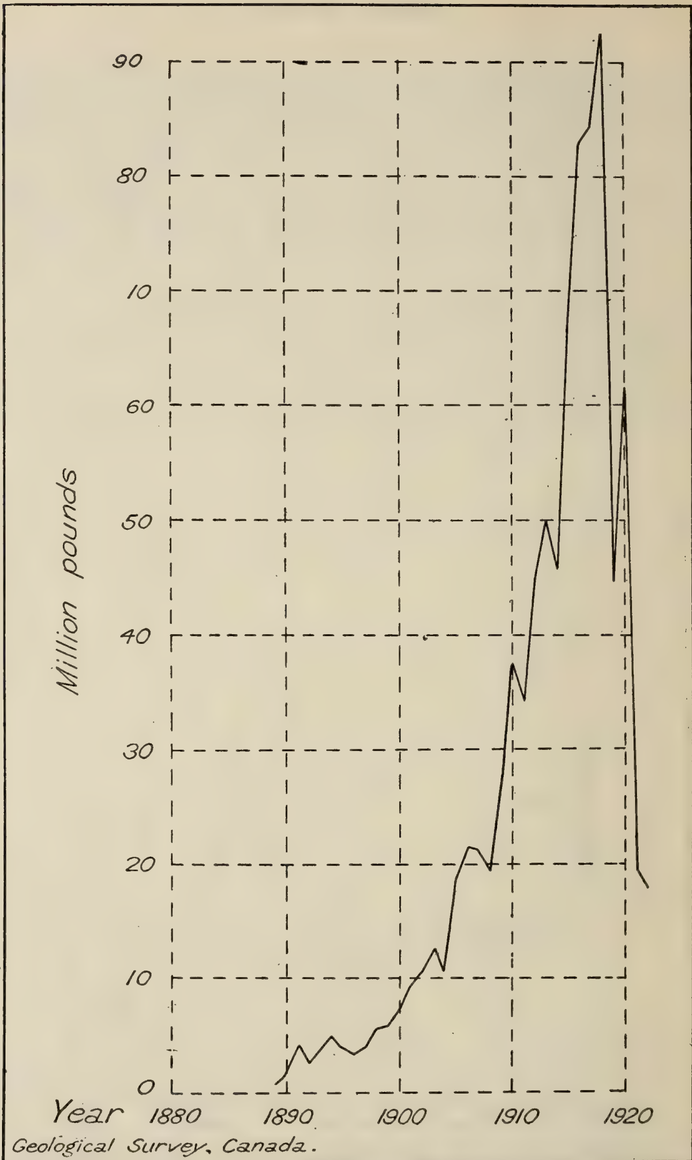

FIG. 53. PRODUCTION OF NICKEL IN CANADA
Showing development of industry, also effects of the war.

operations. Then there arose an insistent demand for the metals required for war purposes with the result that mining operations assumed greatly increased proportions and the value of production rose rapidly, due both to a rise in prices and to an increase in the quantity of production. The armistice was followed by a curtailment of operations which were resumed shortly afterwards with the orgy of extravagance in which the reaction from the restraints of war was expressed. With the slump of 1920 mining operations in general were greatly curtailed. Gold mining was one industry that benefited by the slump; the cost of supplies declined and experienced labour was rendered available and more efficient. There has been a recovery in Canadian mining since and an approach towards normal so far as normal conditions can be established while Europe is in its present chaotic state and the relative distribution of the products of labour in all countries is so disarranged.

Prospects for a continued expansion of the industry are bright. The discoveries and developments of the past may be taken as indications of the possibilities of the future. There remain vast areas for prospecting that are underlain by geological formations similar to those in which very valuable ore deposits have been found. There are also great areas that have been prospected, but not intensively, and valuable mineral deposits have been discovered in recent years in or very near to inhabited sections, such as the salt of Malagash and McMurray, the kaolin of St. Remi d'Amherst, and the magnesite of Grenville. Moreover, developments in chemical, pulp, and metallurgical industries are leading to the exploitation of rocks and minerals that have long been known and have long awaited utilisation, such as limestones of high calcium content, dolomites, quartzites, sodium sulphate, and magnesium sulphate.

The resumption of industries in Europe should have a stimulating effect on mining. Millions on the Continent have been deprived for years of many of the articles that under the present advanced stages of civilisation are regarded almost as necessities, and the restoration of Europe will mean a widening of the market for minerals.

Increasing interest is being taken by the Canadian public in the possibilities of the mineral resources of the country for profitable investment. In this connexion the following table showing the amount of mining securities owned in Canada is worth attention:

DISTRIBUTION OF OWNERSHIP OF SECURITIES ISSUED BY MINING COMPANIES INCORPORATED IN CANADA AS AT DECEMBER 15, 1921

	Canada	Great Britain	United States	Other Countries	Total
Metal Mining	$219,827,250	$72,854,970	$184,859,755	$10,653,067	$488,195,042
Non-Metal Mines.....	131,753,875	23,248,769	47,555,958	7,808,068	211,109,670[1]
Structural Materials and Clay Products..	65,877,195	5,065.034	4,096,940	405,400	75,444,569
Total...	$417,458,320	$101,168,773	$236,512,653	$18,866,535	$774,749,281

[1]Includes $743,000, distribution of which was unknown.

The effect of the opening of a wider door to immigration will be watched with interest. Difference of opinion may exist in the matter, but it is notable that the first decade of this century, which was marked by a large immigration from Europe, was a period of great growth of industrial activity and of striking development in the mineral industry.

PRECIOUS METALS IN CANADA[1]

ALFRED W. G. WILSON, PH.D.
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Precious metals have ever been the lure which has drawn men of all ages to the exploration of the unknown, with the expectation of finding fabulous wealth. The world of to-day owes much of its progress to the discovery of new habitable lands by the visionaries of earlier generations. Canada owes its early discovery and exploration largely to groups of hardy pioneers in search of wealth as a source of happiness. Much of our territory was first seen by Europeans in search of a short route to the mythical wealth of China. Later Canada's wealth in furs lured many a pioneer into unknown wilds, but the possibility of finding gold or silver was always in mind.

Just when gold was first found in Canada is not known. Possibly Nicholas Denys, when he sailed up the Bay of Fundy in 1654, may have obtained some from the Indians of Acadia (afterwards Nova Scotia). Champlain mentions the occurrence of galena on the Quebec side of Lake Timiskaming, a few miles from the now famous Cobalt area, but no reference is made to silver. Placer gold is first recorded from the Gilbert river, 50 miles south of Quebec city, in 1824. Placer mining commenced here in 1847 and intermittent operations have been carried on in this territory ever since. Discoveries in Ontario and in British Columbia were made at much later dates.

Canada extends from east to west about 3,500 miles and from north to south about 1,400 miles, embracing an area of 3,603,910 square miles. It has been estimated that only about 15 per cent. of Canada's area is strictly agricultural land, so that about 85 per cent. is comprised of rocky, sandy, more or less forested areas throughout which mineral wealth is distributed more or less irregularly. Precious metals have already been found in a number of localities throughout this vast territory. These productive areas are widely separated and, therefore, it seems best to consider each by itself. Brief descriptions of the precious metal industries of each producing province from Nova Scotia on the east, to British Columbia and Yukon territory on the west, follow.

[1]Compiled from official records of the Department of Mines, Ottawa, and from records of provincial Departments of Mines.

Accounts of the production of precious metals in Canada prior to 1887 are scattered and irregular; since that date complete records are available. A table has been compiled showing the total recorded production of gold and silver in Canada, by provinces, since 1858, and the general progress in the production of these during the last four decades is shown by graphs. In 1922 Canada stood third among the countries of the world as a producer of gold, and third as a producer of silver. Canada's production of gold is still on the increase, and will probably continue to rise for some years, whereas the world's total production of gold has been gradually declining since 1912. Canada's silver production is below the maximum attained during the height of activity at Cobalt, but a steady, creditable output is still maintained, and new discoveries in the districts around Cobalt give promise of continued production for some years to come.

GOLD AND SILVER PRODUCTION IN CANADA[1]

Province	Record Period	Gold		Silver	
		Fine Oz.	Value	Fine Oz.	Value
			$		$
Nova Scotia.....	1862-1923[2]	912,802	18,869,031	111	74
New Brunswick..	1917	....	....	400	326
Quebec.........	1877-1923	26,834	554,671	2,533,093	2,208,617
Ontario.........	1887-1923	6,169,937	127,544,122	341,118,901	218,446,012
Manitoba.......	1917-1923	4,484	92,524	56,840	57,501
Alberta.........	1887-1923	15,109	312,333	45	37
Br. Columbia....	1858-1923	8,966,676	185,357,829	102,447,540	66,952,536
Yukon..........	1885-1923	8,678,842	179,407,328	4,852,147	3,042,429
All Canada....	1858-1923	24,774,684	512,137,838	451,029,077	290,707,532

[1]Compiled by John Casey, Statistician, Mines Branch. January 23, 1924.
[2]Production for 1923 estimated by Dominion Bureau of Statistics.

Nova Scotia.—It has been known for more than a century that gold occurs in Nova Scotia but no systematic attempt to recover it was made until John Campbell panned gravels on the Atlantic shore near Halifax in 1849. Alluvial gold was found in several localities during the next few years, but there was never any large production. The discovery of auriferous quartz on the Tangier river in 1858 marks the beginning of gold mining in the province.

Gold-bearing strata extend along the Atlantic shore of Nova Scotia from Yarmouth to Canso. The belt of productive territory varies in width from 10 to more than 40 miles; its length is about 275 miles. About 6,250 square miles are underlain by rocks in which productive veins have been found. The gold-bearing measures have been folded into series of undulations whose axes are approximately parallel

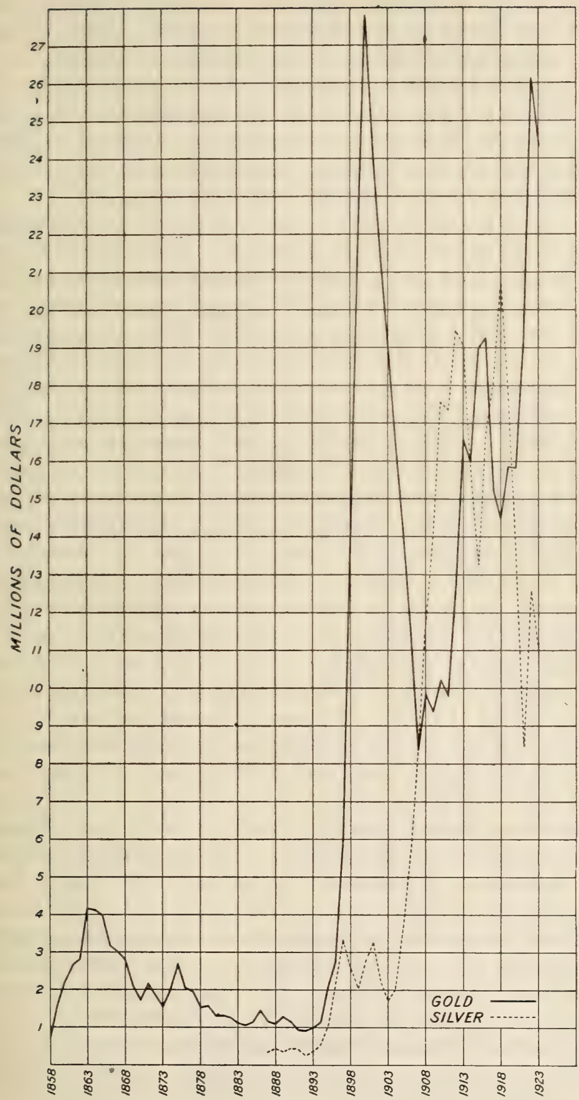

FIG. 54. PRODUCTION OF GOLD AND SILVER IN CANADA
Compiled by John Casey, Statistician, Mines Branch, January 22nd, 1924.

to the sea coast. Auriferous quartz veins occur in groups running parallel to one another along the limbs of anticlines. The number and size of the veins present naturally vary in different localities and the degree of mineralisation is not constant. Some veins have been traced for several thousand feet horizontally, and one was followed to a depth of over 1,600 feet. Most of the mining has been confined to relatively shallow depths. In all more than two hundred mines have been productive at different times during the last sixty years.

The gold is usually present in quartz in a free state; occasionally some may be found in adjacent wall-rock. It may occur in minute flakes, in small nuggets, or in irregular masses, often several ounces in weight. Some veins contain gold almost free from sulphides; others contain pyrite, pyrrhotite, or arsenopyrite. Most of the gold is remarkably pure, about 900 fine, but argentiferous gold flakes and stringers have been recovered from cross-veins in some localities, in amounts sufficient to reduce the gold value to about $16.00 per ounce.

Since the inception of mining in 1862 there has been no single year without some production. In 1862 there was a recovery of 6,863 ounces of fine gold from 6,473 tons of ore. The average yield of gold was $21.91 per ton of ore treated. In 1865 a yield of $20.32 per ton of ore was obtained from 24,421 tons. Since that date there has been a gradual decline in the amount of gold recovered per ton of ore treated. The maximum production in any one year was 30,348 ounces, valued at $627,357 in 1902. In this year 93,042 tons of ore were treated and the average recovery was $6.68 per ton. The lowest yield per ton thus far recorded was $3.71 from 56,790 tons in 1909. Rich ore has been hand-cobbed; in some cases crushing and washing was tried. Most of the recovery has been effected by the use of stamps and amalgamation. Chlorination was also successfully used. At present almost all of the mines are idle.

This region unquestionably contains a very large number of auriferous quartz veins. Concentration and cyaniding under themanagement of larger corporations might prove to be commercially feasible, if the by-products were utilised. Concentrates containing 20 per cent. arsenic could be marketed if enough could be secured to maintain a plant producing about 10 tons of arsenic per day. The value of this by-product would be nearly equal to the mining and concentration costs.

Quebec.—The occurrence of alluvial gold in southern Quebec has long been known. The first recorded discovery was made in 1824 on the Gilbert river, a tributary of the Chaudière, about 50 miles south of Quebec city. Other discoveries were made in this district in subsequent years, but mining did not begin until 1847. Since then, operations have been carried on intermittently by rather primitive methods. Alluvial gold was also found near Lake Megantic about 1906.

The alluvial gold of the Chaudière valley is found in some of the bars along the present streams, but the richest placers appear to lie in the gravel beds of earlier preglacial or interglacial streams which have been intersected by the modern postglacial valleys. The total yield for these placers has been small. Some of the ground might be treated profitably by dredging. The small size of individual holdings makes it very difficult to secure territory large enough for such operations and attempts to promote an enterprise of this kind have been unsuccessful.

A small quantity of gold and silver has been recovered annually from copper pyrites which was mined chiefly in the district south and east of Sherbrooke. Since 1903 the value of the gold in these ores has exceeded that recovered from placers, but the total annual production has always been very small.

Geological work during the last decade has shown that the auriferous measures found in Ontario in the Kirkland Lake area extend eastward into Quebec. During 1922 and 1923 a very large number of claims were staked in Boischatel, Rouyn, Dubuisson, and adjacent townships in northern Quebec, not far east from the Ontario boundary. Active prospecting and developing is now in progress on some properties, and it is confidently expected that the rich gold fields of Ontario will find their counterpart on the Quebec side of the boundary.

Ontario.—Ontario has become the leading mining province of the Dominion within the last few years. Several districts are noted for their gold or silver production, and metals of the platinum group, chiefly palladium, platinum, and iridium are obtained from ores mined primarily for nickel and copper.

Gold was first discovered in Ontario at the Richardson location about 35 miles north of Belleville in 1866. The first finds were spectacular and led to extensive prospecting in the northern part of Hastings county, but no deposits of commercial importance were found and the occurrences of this district are not typical of the areas from which the present large production is obtained. During this period, also, a number of prospects containing auriferous arsenopyrite were discovered. One of these was developed into a mine of considerable importance, which was operated for some years, producing both arsenious oxide and gold. It is possible that the present demand for arsenic may revive operations in this district.

The first important discovery of gold in northern Ontario was made by Peter McKellar in 1871 in Moss township. The property was afterwards known as the Huronian mine. In the following years discoveries were made in the Lake-of-the-Woods district—Sultana, Mikado, Regina, and others—north of Lake Superior, and in the territory

along the international boundary between Lake-of-the-Woods and Lake Superior. Discoveries in the early 'nineties led to a boom which culminated in 1897. The boom as usual was marked by excesses and extravagance. A few successful discoveries of small deposits were developed from which a production of nearly $2,000,000 was obtained. Scattered discoveries were made at a number of other points north and east of Lake Superior and north of Lake Huron.

The accidental discovery of the now famous Cobalt silver area in 1903 attracted hundreds of prospectors who spread out westward and northward from the shores of Lake Timiskaming. Between 1905 and 1920 important discoveries were reported from many localities only a few of which can be named—1905, Playfair; 1906, Larder lake and Abitibi; 1907, Night Hawk lake; 1908, Painkiller; 1909, Munroe and Porcupine; 1910, Swastika; 1911, West Shiningtree and Howry creek; 1912, Kirkland and Whiskey lakes; 1914, Boston creek; 1915, Kowkash-Tashota; 1916, Matachewan; 1917, Richard and Lightning rivers; 1918, Bourkes.

Since the discovery of Porcupine the industry has progressed steadily. The principal producer of this district is the Hollinger, which is one of the world's greatest mines. This property is now treating about 5,000 tons of ore per day, with a monthly production of over $1,000,000. Expansion of this and of other properties has been delayed by a shortage of power, but this is being overcome by the construction of additional hydro-electric plants. It is expected that the output of Hollinger alone will be increased to 8,000 tons per day. The mine possesses an extensive vein system, and the general manager, Mr. A. F. Brigham, has estimated the probable total production from operations above 3,000 feet in depth at $450,000,000. In the last twelve years, chiefly a period of development, this mine has paid in dividends $21,232,000, equivalent to 32.65 per cent. of the production. The total amount of gold produced is in excess of 100 tons. There are two other leading mines in this district, the McIntyre and the Dome; there are also many smaller producers, and active exploration and development is in progress on many claims.

The Kirkland Lake field was discovered in 1912. There are now about twenty-one properties in this territory in various stages of development, five of which—Kirkland Lake, Teck-Hughes, Lake Shore, Wright-Hargreaves, and Tough Oakes—have already become important producers. Some of the ores contain calaverite, kalgoorite, and hessite, as well as native gold.

Gold occurs in Ontario associated with several varieties of Precambrian rocks, which consist for the most part of schists which have been intruded by granites or porphyries. It is not possible to discuss

the complex geology of these gold fields within the limits of this article. It may be stated, however, that the area underlain by these complex Precambrian rocks is very large and that it will be many years before the most promising gold-bearing districts are mapped in detail.

Prior to the discovery of the Porcupine and Kirkland Lake fields the gold production of Ontario was small. Between the years 1887—the first for which there is any record—and 1909, the total recorded production was 118,366 ounces valued at $2,446,835. In 1912, 102,278 ounces valued at $2,114,086 were produced and since that date, except during the period of the war, there has been a steady increase in annual production. Ontario is the only important gold-mining area where there has not been a decline in production since 1915.

Silver is said to have been found by a Russian near Sault Ste. Marie before the year 1800. This is possible because native silver in association with native copper has been found at Point Mamainse on Lake Superior. Veins carrying silver were found on Lake Superior as early as 1846 but the first important discovery was made by Peter McKellar on Thunder bay in 1866. In the next four years other discoveries were made, but the total recovery of silver was small until the famous Silver Islet mine was opened in 1870. In fourteen years this mine yielded $3,089,157; the average value of the ore was about $1,500.00 per ton, and some shipments yielded as much as $7,000.00 per ton. The mine was closed in 1884 and was re-opened for a short time in 1921. Rich but limited ore shoots were discovered on other properties in the Thunder Bay district. Production was intermittent and steadily declined, falling to $8,949 in 1903, the year of the discovery of Cobalt.

The construction of the Timiskaming and Northern Ontario railway, as part of a colonisation and development plan of the government of Ontario, accidentally led to the romantic discovery of the Cobalt silver field in 1903. The first year of production was 1904, and the extraordinary value of the discovery was not recognised until a year later.

The silver deposits of this district are found in association with Precambrian rocks into which has been intruded a batholithic diabase. The rich ores occur in veins which vary in width from a mere crack to at least a foot; the adjacent wall rock may also carry silver in an amount sufficient to produce a milling ore. The width of stopes is frequently about six feet, but in some instances they may be fifteen feet or more across.

In the early days of the Cobalt camp the rich ores were merely hand sorted and shipped to smelters. At the present time the yield of very high-grade ore has greatly declined and the principal mines

all employ modern concentrating mills. The concentrates are treated in Canada for the recovery of silver, cobalt, arsenic, nickel, and other metals.

The silver production of Ontario reached a maximum of 30,540,754 ounces in 1911, valued at $16,279,443. The next year's production was 1,326,729 ounces less, but owing to the increase in the market price of the metal, the valuation rose to $17,772,352. Production has declined since 1911 to about 9,900,000 ounces per annum, at which figure it has remained for the last four years.

Platinum, palladium, iridium, and other metals of the platinum group are found in association with the nickel-copper ores of the Sudbury district. The amount present differs in the ores from different mines. These ores are treated in blast furnaces to produce a rich matte, the concentration being about twenty to one. Naturally there is some loss of precious metals, but the mattes contain appreciable amounts. The average content of the mattes for a three-year period was reported by one operating company to be: gold 0.05 ounces, silver 1.75 ounces, platinum 0.10 ounces, and palladium 0.15 ounces. The precious-metal content of the matte is not always recovered because of the processes employed in the production of refined nickel, copper, and monel metal. Where the mattes are treated by an electrolytic process, or by the Mond process, the recoveries are good. There is, therefore, a small annual production of precious metals from this source. Complete records of the recoveries of metals of the platinum group are not available.

Prairie Provinces.—The northern parts of Manitoba and Saskatchewan are underlain by metamorphic crystalline rocks in which auriferous quartz veins have been found in a few localities, particularly in parts of Manitoba. Several deposits of copper pyrites have also been found which contain small amounts of gold and silver. These ores are accountable for the silver production of Manitoba noted in the statistical statement. Prospecting has been in progress for some years in the territory north of the Saskatchewan river and along the Nelson. Mining exploration has taken place, also, in parts of northern Manitoba, but no property has yet been developed to the point of steady production.

Alberta contains areas of crystalline rocks in the remote north-eastern part of the province. No production has yet been recorded from this territory. Some of the streams flowing down the eastern slopes of the Rocky mountains have formed placer deposits. Placer gold in a very fine state of division is known to occur in the bars of the Saskatchewan river, even below Edmonton, and there has been a small recovery from this source.

A production of 4,484 ounces of fine gold, valued at $92,524, and 56,840 ounces of silver, valued at $57,501 was obtained in Manitoba during the years 1917-23.

Saskatchewan is not credited with any recorded production of precious metals.

Alberta has been producing gold at least since 1887, but no production is noted for the years 1913, 1917, 1920, 1922, and 1923. The total production recorded is 15,109 ounces of fine gold, valued at $312,333. In 1917, 45 ounces of silver, valued at $37.00 were recorded, the only production of this metal credited to the province.

British Columbia.—Reports of the discovery of placer gold in the Fraser River bars reached California in 1857, eight years after the famous gold rush of 1849. The next year saw an influx of over 14,000 miners into this territory. Many of these prospectors were doomed to disappointment, but some of the more hardy pioneers penetrated to the upper waters of the Fraser and Thompson rivers, discovering the famous Cariboo placers, first on Antler creek and later (1860) on Williams and Lightning creeks. About 1869 gold was found in the Omineca district and in 1874 the famous Cassiar was discovered. In due course individual mining fell off, the organisation of syndicates or corporations and the grouping of claims followed, and hydraulicking and dredging operations were begun. Placer production has been steadily declining since the maximum, attained in 1863, when gold valued at $3,913,563 was recovered, but important areas still await the development of dredging enterprises.

In 1890 all the more important lode mines of the Rossland camp were located. The next year witnessed the discovery of the rich silver-lead mines of the Slocan. Prospecting has since continued throughout the province with varying success.

The gold production of British Columbia has been derived in part from the placers, in part from auriferous quartz lodes, and in part from auriferous sulphide ores which also contain copper and silver. Silver production has been derived in small part from the auriferous sulphides, but the chief source is the rich lead and silver ores of the Slocan district. Similar ores have since been found in other parts of the province.

There has been a small intermittent production of placer platinum from the Tulameen valley and from other points. Small quantities of black platiniferous sands are occasionally collected at certain places in the riffles of sluice boxes when washing gold gravels. The total production has been small.

The principal gold-producing areas to-day are the Cariboo, Omineca, and Cassiar districts; Rossland, Hedley, Howe Sound, and the

Portland Canal district. The principal mines at Rossland have been idle for two years awaiting the development of concentrating methods and the building of a mill. It is expected that operations will be resumed this year.

The principal silver-producing area is the Kootenay district, but this metal has also been recovered from ores in other districts, particularly near Hazelton and on the Portland canal.

The geological conditions under which these different metals occur are too varied and complex to be discussed within the limits of a short article.

The maximum production of gold in British Columbia was 286,858 ounces, valued at $5,929,880, in 1908. Between 1901 and 1915 the annual production never fell below $5,000,000. Since 1916 there has been a decline, and the estimated production for 1923 is valued at approximately $3,411,000.

Silver production attained its maximum in 1901 in which year 5,151,333 ounces, valued at $3,036,711, were produced. Between 1906 and 1915 there was a marked decline, since which date there have been slight advances. The estimated production for 1923 is valued at $3,835,000.

Yukon.—Discovery of placer gold in Yukon was probably made by employees of the Hudson's Bay Company at least as early as 1868. During the next twenty-five years an occasional prospecting party found its way into the country. Some of these were successful, and in 1886 Dr. George Dawson found miners recovering as much as $100 a day on the Stewart river. He estimated the total recovery of gold from this river at that date to have been over $100,000, while Fortymile had yielded at least $120,000.

The Klondike was discovered by the finding of gold on Quartz creek in 1894. The next year, gold was found on Goldbottom, a creek tributary to Hunker, and a year later the richness of Bonanza became public. The dissemination of the news of this discovery throughout the world started the historic rush of 1897-98.

The Yukon placers reached the peak of their production in 1900—1,077,553 ounces valued at $22,275,000. At that time the population of the territory was about 30,000 people. As work became unprofitable claims were gradually abandoned, or were consolidated into groups by large corporations for operation on a large scale with modern dredging and hydraulic equipment. During the last decade there has been a moderate but steady production, chiefly from the large-scale operations of several corporations, but the output is now declining.

The productive area lies east of the Yukon river. It is bounded on the north by the Klondike, and on the east by the Flatcreek, a

tributary of Indian river, which lies to the south. The gold fields are confined to an area of about 800 square miles. The region is a country of long, branching, interstream ridges which rise to about 1,500 feet above the adjacent valleys. The general elevation of the ridges is about 8,200 feet above sea level.

The placers first worked were gravel beds in the valley bottoms. Early in the prospecting it was found that rich auriferous gravels lay along the benches, sometimes high above the valley bottoms. Shallow ground could be profitably worked by hand, but deep ground was usually frozen and had to be thawed by wood fires before the gravels could be washed. In 1899 methods of using steam for thawing were devised and applied.

Present practice for large-scale operations in the valley bottoms is to thaw a given area of ground systematically by the use of specially designed equipment which distributes superheated water to the gravel beds. The loosened ground is then handled in huge bucket dredges. The coarser cobbles are screened out and the finer material is passed to sluices where the gold is retained and the gravel washed away. The washed gravel and coarse debris are discharged on the ground behind the dredge. Bench deposits are usually handled on the large scale by hydraulicking.

Quartz veins are abundant in certain schists known as the Klondike series, and they are less prevalent in the other rocks of the district. The veins are usually small, but persistent, and carry iron and copper pyrites, galena which is sometimes argentiferous, and free gold. The quantity of gold present in different veins varies considerably. While more than one thousand quartz claims were staked in Yukon the amount of gold recovered from these veins is comparatively unimportant.

Yukon placer nuggets usually contain a small amount of silver, and the value of the gold present is about $16.50 an ounce.

In recent years a number of silver-lead prospects have been located in Yukon. Rich ores are being mined in the Mayo district. These are shipped to California for treatment. The present rate of production amounts to about 1,000,000 ounces per annum.

THE CHEMICAL AND METALLURGICAL INDUSTRIES OF CANADA

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In three, at least, of the pioneering activities of the early settlers rests the genesis of Canadian chemistry. The production of maple sugar, the compounding of a crude soap, and the manufacture of "potash"—these were the original chemical industries of this country. We may now, perhaps, in the interests of a long-delayed justice, even classify as "chemical" the knowledge of medicinal plant extracts and stains, possessed by native tribes, and developed by them, through the practice of sound principles of observation and research. However good a case might be made out, further delving into this last field will not be undertaken here.

The process of recovering maple sugar from sap has become a classic reference to things Canadian. School children and finished prose-writers have dealt with the subject quite completely. Much of the romance departed with the introduction of modern evaporators, and, strange to relate, even American coal may be found concentrating sap in the midst of a Canadian sugar-bush. The production of soap was a family activity; while the making of "potash" attained the status of a fairly well organised industry.

An old-time ashery was truly a chemical plant. Many of the operations of some modern establishments were practised. Substances were not named by an international congress of scientists. A mixture of some crystals, with their mother liquor, while still in the pouring state, was called "salts", while the general residue from the evaporation of the water-soluble portion of hardwood ashes was named "potash". Given modern equipment, belt conveyors, and multiple-effect evaporators, the same set of operations would be considered quite complex chemical engineering. Imagine, if you will, a community cutting down and burning up great piles of the choicest mature timber, and gathering, at a central plant, really enormous quantities of ashes. Here might be seen from twelve to twenty leaching-vats made from plank, each vat being ten feet wide, twelve feet long, and five feet deep. These were erected at a slight angle, and, for each run, their bottoms were covered with fresh straw. When filled, water (generally secured by

hand-pumping) was allowed to pass through the ashes; and the lye thus formed was evaporated in the first stage in iron kettles, by means of much firing with wood. The art of concentrating the last of the run, by passing it through fresh ashes, was well known. After a preliminary evaporation, the partly concentrated liquor was transferred by hand to a special kettle reserved for final evaporation. The process was stopped at a point where, when the concentrate was removed to an iron barrel, it would solidify. The last container was, in reality, a mould. The solid "potash", on cooling, fell away from the sides and was ready to be transferred to a shipping-box. This was a wooden barrel of crude manufacture made so that it would fit the cake of salts.

What was the peculiar lure that stimulated this activity? There was a stern economic factor to be considered. The best of labour was available for almost nothing. There was but very little money in circulation. A system of exchange gave those opening up the country a few necessities for what they could produce. This "potash" was about the only commodity for which real cash could be secured. At a time when every standard was so low, it will be appreciated that one hundred and twenty-five dollars for a barrel of "potash", or a matter of twenty to twenty-five cents a pound, was wealth as great as the imagination of those engaged in the business could conceive. With such sacrifices of natural resources was agriculture established in many parts of this country.

Some conception of the rapidity of developments may be secured by remembering that there are those still actively engaged in the chemical business who have exceedingly vivid, first-hand recollections of earlier times, when there was absolutely no chemical industry in the country, as we understand the significance of the term to-day.

Within a brief space, Canada has attained, in some respects, a remarkable degree of self-containment in chemical and metal production. There are chemical works producing heavy acids; many salts; soda ash; ammonia; ammonium sulphate; refined wood-distillation products; alcohol of the highest purity; ether; chloroform; and a surprising number of pharmaceutical products, specific medicinal chemicals, and plant extracts; petroleum products; pine oils; acid phosphate; metals and metallic salts; liquid chlorine; caustic soda; bleaching compounds; sodium and magnesium sulphate from natural brines; carbide; cyanide; cyanamid; phosphorus; synthetic acetic acid; carbon black from acetylene; aldehydes; hydrogenated oils; phenol condensation products; and specialties for textile, tanning, paper, and paint industries. Such a list could be extended if it were necessary to go further to show that Canada holds her place in chemical production.

In the production of metals, British Columbia leads in copper, zinc and lead, and is by no means behind in gold and silver. In Ontario, complete refineries are operating for the production of nickel, cobalt and its salts, arsenic, and, of course, gold and silver in quantities, that have focussed the attention of the world on that province. The production of aluminium is centred at Shawinigan Falls, Quebec, while, in the Niagara-Hamilton district in Ontario, ferro-alloys and abrasives are made. The iron and steel industry, with coke-plants, is located in Ontario and in Nova Scotia. The production of molybdenum and chromium products, flake graphite, and metallic magnesium suffered, following war-time development, but, while relatively dormant, these industries are well within the range of Canadian possibilities at any time.

In the non-metallic mineral division, including clays, resources are important and developments have been rapid. There is an abundance of feldspar of fine quality in Ontario and Quebec. Central Ontario, or the district of which Kingston is the centre, has given evidence of special mineral resources, perhaps the most widely known being the talc production of Madoc. But one deposit of china clay has been developed, a small works being in operation at Huberdeau, Quebec. The magnesite industry awaits only a larger market. Of special clays suitable for fire-brick there appears to be a scarcity in central and western Canada, while there is no lack of good clays for ordinary purposes. Ottawa is a general centre for the mica industry.

Many of these developments are so recent that it is difficult to treat them from the point of view that is usually considered historic. A few notes may be interesting. It is claimed that sulphuric acid was first made in Canada in the vicinity of Belleville, Ont. The first works was established at London, Ont., in 1866. The sulphur used came from Sicily and the concentration of the acid was a hazardous business. Acid strength was measured by the charring effect of the concentrate on sawdust and the rapidity with which the hot solution cleared up. The early production of this essential chemical was so surrounded with difficulties of a practical and technical nature that it is remarkable indeed that any attempt was made. Pyrites came to be used as a source of sulphur, but suitable deposits were not always located readily. As has been the case in many instances, the original producers suffered from a most unjust prejudice against a domestic article. This first acid-works was started at London, Ontario, because of the demand from the then-recently discovered oil fields around Petrolia. It is recorded that early refiners insisted on importing acid made in Cleveland, Ohio, until a rather clever piece of salesmanship, combined with the tricky temper of shallow Lake Erie, came to the rescue of Canadian producers.

As the story is told, it would appear that an industrial fair of some magnitude was promoted at Cleveland and prizes were offered for a great variety of products. The enterprising Canadian company sent over a large carboy of their acid and took considerable pains to decorate the container. As the judges' decision did not go beyond an examination of the container, the Canadian acid secured first prize. This, coupled with an incident that happened to a deck-load of acid on a small lake-boat caught in a storm, paved the way for a trial of the Canadian acid at the new oil refineries, and, of course, the great discovery was made that the domestic product worked just the same as the best that had been imported previously.

The element of scientific romance exists in the development of calcium carbide by the late Thomas Willson. Perhaps it is not out of order to point to the coincidence that, at this time, in the identical location and plant where carbide was first made in Canada and with the same power, the Electro-Chemical Co. at Thorold, Ontario, is now undertaking the production of synthetic nitric acid and nitrates by the rotating arc process of Dr. J. S. Island.

The spirit of chemical adventure is still with us and the will to succeed has not departed. Wisdom and a knowledge of the laws of matter are things to be obtained; and we should prize highly those torch-bearers who enter dark places in the maze of chemical manufacturing as well as those who, from the relative safety of the laboratory, send forth philosophies.

Perhaps the two outstanding accomplishments in chemical production in Canada, during the recent war period, were the production of acetic acid and acetone from carbide at Shawinigan Falls, Quebec, and the magnitude and yield of the operations by which acetone was produced by corn fermentation at Toronto. Each, in its own way, was an extremely difficult task, well done by individuals who, in the main, were dependent upon their own scientific and mechanical resources.

To secure a conception of the fundamentals that are stimulating progress in these industries, at least five factors must be considered. They might be taken as: (1) The availability of electric power from waterfalls. (2) The richness of certain natural resources. (3) The large home consumption of some chemicals in certain well-developed, special Canadian industries. (4) The inherent desire of the Canadian people to secure a self-contained system of manufacturing processes. (5) The development of a number of universities, where courses in engineering and chemistry are given and research methods taught that qualify graduates to carry on the development of Canadian industries.

Considering Canadian chemical and metallurgical industries from such a standpoint, it is obvious that those using electric power in electric furnace operations must seek out locations where such power is available in quantity and may be developed at the lowest cost. This explains, at once, the location of a cyanamid works on the Ontario side of Niagara Falls, which ships nearly all its production to the United States, or the erection of an aluminium works at Shawinigan Falls, Quebec. Power-using chemical and metallurgical works will continue to be attracted to such centres. The mining industry of northern Ontario is singularly dependent upon the development of hydro-electric power. The location of coal resources makes it imperative that every possible source of such power in the central portions of Canada be developed in such a way that finally it will be used with the greatest efficiency, so that the fuel handicap may be to some degree overcome. This situation, in all probability, will result in the rapid development of systems of carbonisation that will establish coke and by-product plants in Ontario and Quebec to a degree that might not be the case were coal available in these provinces.

In respect to resources, those already discovered cover a wide range, and while it may be true that in iron ore, oil and coal, certain difficulties exist, the last word has not been said or written, and it will be considered strange indeed if oil in quantity is not yet found and if research cannot find a way to use the quite large bodies of iron ore that are nearly, but not quite, able to compete with the specially favoured deposits of the United States.

Perhaps it is an example, and it may be a natural characteristic of the races coming together in Canada; but it must be clear to any observer that a very full and complete development of a resource is undertaken just as soon as there is a market able to absorb a reasonable supply.

The situation in salt products may be taken as an example. The beds underneath the district of Windsor, Ont., have been known for a long time and were operated by a number of companies, producing salt for domestic and non-chemical purposes. Now, however, those deposits are producing soda ash, liquid chlorine, caustic soda in all forms, liquid bleach, and bleaching-powder. In Nova Scotia other salt deposits are being developed. With certain industries where quantities of bleach are necessary it is but a short step to the production of these chemicals, in a more or less local way, at other points throughout Canada.

For a considerable time, nickel ore was smelted in Canada and refined elsewhere. During the last few years two complete refineries have been erected. One of them, using an electrolytic method, naturally located at a source of power near the city of Ottawa.

Canadian trade returns in the chemical field are scanned by manufacturers and, as soon as imports appear to warrant production (and sometimes much before this period), some capital is generally available to undertake the promotion of any given special line of business.

This semi-national policy of self-containment may be illustrated further by such development as the production of sesquisulphide of phosphorus in quantity at a match works. In theory, this may not conform with a proper division of labour, but in such ways chemical industries start and spread.

There are some phases of Canadian metallurgy that offer serious problems not yet worked out. Lack of density in population is the chief retarding element. In brief, the smallness of the Canadian market coupled with its scattered nature presents a situation not readily adjusted. In Nova Scotia a considerable coal, iron and steel, and coke industry has developed. Newfoundland iron ore and Nova Scotia coal combine to present a very excellent basic manufacturing system. If a greater density of population were immediately available it would be much easier to serve not only the local industry but the St. Lawrence market. Alberta has remarkable resources in coal. Ontario has iron ore; but, under present conditions, the steel industry in Ontario uses both United States coal and ore. Here again a little larger market is required to produce a much larger and more self-contained metallurgical industry. British Columbia has certain resources in coal and iron ore and is situated on a potential Pacific market; but it is difficult to determine just when it will be advantageous to undertake an iron and steel industry in that Province because local consumption is relatively small. Regarding the future, in a general way there is no doubt.

Here a little and there a little, chemistry has grown in Canada since 1918. There have been unobserved movements, such as the production in a larger way of textile oils and soaps and the research work carried on by the Shawinigan Group. Such developments as the working up of lake deposits of sulphates in Saskatchewan and British Columbia have received more attention. Here is a resource in its way as remarkable and as valuable as that available to any country. A rather unusual deposit of magnesium sulphate has been partly developed at Basque, B.C., while there are several companies in the field in connexion with lake deposits in Saskatchewan. Still more outstanding in one sense has been the effort to produce dyestuffs in a small way. In the general organic field the basic industries are established; and, if precedent is an indication, it is not likely that the production of some dyestuffs and a number of general organic

and pharmaceutical products will be greatly delayed. An example of the development of a complete textile industry is to be seen in the plan to produce artificial silk at Cornwall, Ontario.

Perhaps the general application of chemistry to industry is a gauge of progress. During the last few years chemical laboratories have been established by many Canadian manufacturers. They have found them to be a good investment. As examples, a co-operative laboratory has been established by the Canadian Woollen Manufacturers' Association and the same plan is being adopted by the baking industries. These type movements may not seem to be much of a reward, when the very considerable effort that has been put forth by leading scientists in the interest of industrial research is considered; but they are the ventures of industries weathering uncertain storms and they indicate a confidence in this type of progress, not previously in evidence. Canadian industries have always had a good measure of chemical direction; but the new interest is worth observation.

Chemical statistics are available for Canada. In fact, this is a post-war development. The Bureau of Statistics of the Department of Trade and Commerce maintains a Chemical Branch. Reports covering these industries in some detail were issued in 1919 and 1921. In addition, much specific, special information is available through this department.

It is easy to magnify and equally possible to underestimate the chemical industries of Canada, the application of chemistry to Canadian industries, and the teaching of chemistry in Canadian institutions. Rather broadly considering the matter, Canadian industries have not found it possible to give the same detailed attention to by-product possibilities. In some cases, where conditions do not allow for the exact duplication of some European developments, there may appear to be much waste. Perhaps this may be charged against the pulp and paper industry, which, on the whole, is concerned with the production of newsprint almost entirely. The industry is fully advised of losses, but an economic solution is required. The chemical industries taken together have reached and, in some selected groups have quite passed, domestic requirements. Canada is, of course, a large importer of chemicals, but she is also a producer and exporter.

In research, the Dominion government has recognised, to some extent, the necessity for the education of industry upon the possibilities of scientific and industrial research. While problems of the utmost importance are apparent and are in the hands of Government laboratories and agricultural schools, it is obvious to those who have a sure knowledge of the research method that important strides might

be taken by a little more co-operative and massed application of scientific workers. Canada has problems in forestry and agriculture alone that are fundamental to the country's largest sources of revenue. Rust is robbing wheat-growers of $100,000,000 a year. Chemistry may not play a major part, but it is a well-tried instrument and essential.

The progress that has been made in chemistry and in industry by means of chemistry eventually comes back to the influence of individual chemists and the development of the teaching of chemistry and chemical engineering. Canada has received much help from those who brought their chemistry with them from Europe and, to a lesser extent, from the United States; but the mainspring of Canadian chemistry abides in the faculties of the universities. During the last two generations, chemistry and research have been fostered so well that graduates have been able not only to accomplish the development work required in Canada but have, in many instances, found themselves equipped with an ability to hold important places in the much larger development so nearby to the south. Behind the chemical and metallurgical industries of Canada are Canadian universities (staffed by men of outstanding research ability in many instances) and an educational system that was planned well in advance to supply the training for those who must eventually direct developments in this part of the Empire. In particular, the Faculties of Chemistry and Chemical Engineering at the University of Toronto, at McGill, and at Queen's have left their mark on chemistry in America as a whole. Now in all provinces may be found faculties engaged in maintaining these standards.

In chemistry, as in everything Canadian, the outline is there. The canvas is large but the artists, although busy, are few. The field has been staked, and, as general developments are made, there will be ample opportunity for the application of chemical principles and chemical research.[1]

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[1]For bibliography see appendix.

APPENDIX

SELECTED BIBLIOGRAPHY

For the assistance of those desiring further information on the subjects treated in this handbook short bibliographies have been furnished by many of the authors, as follows:—

THE GROWTH OF POPULATION IN CANADA
IMMIGRATION AND LAND SETTLEMENT IN CANADA
SETTLING THE PRAIRIES
RACE IN CANADA

DOMINION BUREAU OF STATISTICS AND CENSUS.—Reports, Ottawa.

DOMINION DEPARTMENT OF IMMIGRATION AND COLONISATION.—Reports, Ottawa.

DOMINION DEPARTMENT OF INDIAN AFFAIRS.—Reports, Ottawa.

DOMINION HOUSE OF COMMONS.—Debates on Oriental Immigration (Sessions of 1912-13; 1922), Ottawa.

IMMIGRATION COMMISSION OF U.S.A.—Reports, Washington.

BRITISH COLUMBIA DEPARTMENT OF AGRICULTURE.—Survey of Land Ownership by Orientals in British Columbia; Victoria, 1920.

TREATY AGREEMENT BETWEEN UNITED KINGDOM AND JAPAN.—Treaty Series: 1911, No. 18.

VITAL STATISTICS OF THE PROVINCES.

VOTES AND PROCEEDINGS IN THE ASSEMBLY OF BRITISH COLUMBIA.—Session 1922, Nos. 15, 34, 35.

F. H. ADAMS.—The Administration of Indian Affairs in Canada, 1915.

J. T. M. ANDERSON.—The Education of the New Canadian, 1918.

CANADIAN RECONSTRUCTION ASSOCIATION.—Suggestions for Land Settlement, Toronto, 1921.

I. CARON.—La Colonisation du Canada; L'Annuaire Statistique de Quebec.

LA COLONISATION DE LA PROVINCE DE QUEBEC.—Le Canada Français, Vol. III, No. 5.

CONSULATE-GENERAL OF JAPAN.—Facts about Japanese in Canada; Ottawa, 1922.

S. A. LORTI.—L'origine et le parler des canadiens-français, 1903.
Origine des premiers colons canadien-français, 1915.

H. A. MILLS.—The Japanese Problem in the United States, 1915.

E. H. OLIVER.—The Country School in non-English-speaking Communities in Saskatchewan, 1915.

G. PELLETIER.—Le Partage de l'immigration canadienne depuis 1900; Trans. Roy. Socy. Can., Ser. III, Vol. XII, Sec. 1, 1919.

K. SATO AND T. IYENEGA.—Japan and the California Problem, 1912.

G. W. SMITH.—A study in Canadian Immigration (A pioneer general survey. Statistics insecure), 1920.
J. S. WOODSWORTH.—Strangers within our Gates, 1909.

THE GOVERNMENT OF THE CANADIAN FEDERATION

W. P. M. KENNEDY.—The Constitution of Canada; Clarendon Press, 1923.
SIR ROBERT BORDEN.—Canadian Constitutional Studies; Toronto, 1922.
LEFROY AND KENNEDY.—Canadian Constitutional Law; London, 1918.
W. P. M. KENNEDY.—Documents of the Canadian Constitution; Oxford, 1918.
W. R. RIDDELL.—The Constitution of Canada; New Haven, 1917.
W. R. RIDDELL.—The Canadian Constitution in Form and Fact; New York, 1923.

CANADA'S NATIONAL PARKS

STEWARDSON BROWN AND MRS. CHARLES SCHAFFER.—Alpine Flora of Canadian Rocky Mountains; Putnam, 1907.
W. SPOTSWOOD GREEN.—Among the Selkirk Glaciers; MacMillan, 1890.
W. A. BAILLIE-GROHMAN.—Camps in the Rockies; H. Clark Co., Cleveland, Ohio.
A. P. COLEMAN.—The Canadian Rockies; Henry Frowde, Toronto.
J. NORMAN COLLIS AND H. E. M. STUTFIELD.—Climbs and Explorations in the Canadian Rockies; Longman Green.
SIR SANDFORD FLEMING.—England and Canada.
From Old to New Westminster.
W. H. SCHERZER.—Glaciers of the Canadian Rockies and Selkirks.
W. D. WILCOX.—Guide to Lake Louise Region; Judd and Detweiter, Washington.
JAMES OUTRAM.—In the Heart of the Canadian Rockies; MacMillan.
SIR G. SIMPSON.—A Journey round the World; Henry Colburn, London.
P. DE SMET, S.J.—Missions de l'Oregon.
HOWARD PALMER.—Mountaineering and Explorations in the Selkirks; Putnam.
F. A. TALBOT.—New Garden of Canada; Cassell.
GEORGE M. GRANT.—Ocean to Ocean; S. Low, 1873.
W. D. WILCOX.—The Rockies of Canada; Putnam.
EARL OF SOUTHESK.—Saskatchewan and the Rocky Mountains; Edin. Hamilton, 1875.
A. O. WHEELER AND ELIZABETH PARKER.—A Guide for Mountain Pilgrims and Climbers; Stovel Co., Winnipeg.
A. O. WHEELER.—The Selkirk Range; Dept. of Interior, Canada.
H. Palmer.—Three new Climbs in the Selkirks.
F. YEIGH.—Through the Heart of Canada; Henry Frowde, Toronto.
ALEXANDER MACKENZIE.—Voyage through North America; London, 1801. (Popular edition; Barnes, New York, 1903).
E. W. D. HOLWAY.—First Ascent of Mount Edith Cavell, etc.
A. O. WHEELER.—Some Meteorological Phenomena of the Canadian Rockies.

S. WASHBURN.—Trappers and Tenderfeet; Holt, New York.
E. DEVILLE.—Description of and Guide to Jasper Park; Dept. Interior, Canada.
R. A. DALY.—Geology of North American Cordillera; Geol. Survey, Canada.
JULIA W. HENSHAW.—Wild Flowers of the North American Mountains; Robert M. McBride, New York.
J. B. TYRRELL.—David Thompson's Narrative of his Explorations in Western America; Champlain Society, Toronto.
P. A. Taverner.—Faunas of Canada; Dept. Trade and Commerce, Canada, 1915.
CHARLES E. FAY.—Recent Mountaineering in the Canadian Alps.
H. PALMER AND J. MONROE THORINGTON.—Climber's Guide to the Rocky Mountains of Canada; Knickerbocker Press, New York.
J. K. HENRY.—Flora of Southern British Columbia; W. J. Gage, Toronto.
HOWARD PALMER.—Topography of the Gold Range and Northern Selkirks.
P. A. RYDBERG.—A Flora of the Rocky Mountains and Adjacent Plains; Author, New York.
C. W. STOKES.—Round about the Rockies; Musson.
M. B. WILLIAMS.—Through the Heart of the Rockies and Selkirks; Dept. of the Interior, Canada.
C. MARIUS BARBEAU.—Indian Days in the Canadian Rockies; MacMillan.

THE CLIMATE OF CANADA

DOMINION METEOROLOGICAL SERVICE.—Annual Reports, 1870-1915; Toronto.
METEOROLOGICAL OBSERVATIONS, CANADA, NEWFOUNDLAND, AND BERMUDA.—Monthly Record, 1916, 1923; Toronto.
ANNUAL BULLETIN OF OBSERVATIONS.—Toronto.
TEMPERATURE AND PRECIPITATION OF BRITISH COLUMBIA.—Toronto, 1915.
TEMPERATURE AND PRECIPITATION OF ALBERTA, SASKATCHEWAN, AND MANITOBA.—Toronto, 1920.
TEMPERATURE AND PRECIPITATION OF ONTARIO.—Toronto (Publication delayed).
DOMINION BUREAU OF STATISTICS.—Canada Year Book (annual).
BUREAU OF STATISTICS, QUEBEC.—Statistical Annual.

WATER POWER IN CANADA

COMMISSION OF CONSERVATION, CANADA.—Water Powers of Canada, 1911.
COMMISSION OF CONSERVATION, CANADA.—Water Powers of British Columbia, 1919.
COMMISSION OF CONSERVATION, CANADA.—Water Powers of Manitoba, Saskatchewan, and Alberta, 1916.
WATER POWERS BRANCH, DEPARTMENT OF THE INTERIOR, CANADA.—Various Reports.
ONTARIO HYDRO-ELECTRIC COMMISSION.—Annual Reports.

PIONEER TRANSPORTATION IN CANADA

Transportation in the Fur Trade:

GEORGE BRYCE.—Remarkable History of the Hudson's Bay Company; Toronto, 1900.
ISAAC COWIE.—The Company of Adventurers; Toronto, 1913.
L. R. MASSON.—Bourgeois de la compagnie du nord-ouest; Quebec, 1889.
G. C. DAVIDSON.—The North West Company; Berkeley, 1918.
ALEXANDER ROSS.—Fur Hunters of the Far West; London, 1855.

Early Shipping on Canadian Inland Waters:

JAMES CROIL.—Steam Navigation; Toronto, 1898.
BARLOW CUMBERLAND.—A century of Sail and Steam on the Niagara River; Toronto, 1913.
J. C. MILLS.—Our Inland Seas; Chicago, 1910.
J. O. CURWOOD.—The Great Lakes; New York, 1909.
F. H. SEVERANCE.—An Old Frontier of France; New York, 1917.
WISCONSIN HISTORICAL SOCIETY.—Publications: General Index under Transportation; Sailing Ships on Great Lakes; Steamships on Great Lakes.

First Canadian Canals:

T. C. KEEFER.—Canals of Canada; Toronto, 1850.
WILLIAM KINGSFORD.—Canadian Canals; Toronto, 1865.
ERNEST MARCEAU.—Early Canals; Transactions Canadian Society of Civil Engineers, 1907.
REPORT OF CANAL COMMISSION ON IMPROVEMENT OF INLAND NAVIGATION OF CANADA.—Ottawa, 1871.
HOUSE OF COMMONS RETURN.—Reports on Canadian Canals; London, 1832.
REPORT ON CANADIAN ARCHIVES.—Internal Communication in Canada; Ottawa, 1890.
REPORT ON CANADIAN ARCHIVES.—Canadian Canals; Note D, 1886, 1889.

Early Canadian Shipping on the Sea:

HENRY FRY.—History of North Atlantic Sea Navigation; London, 1896.
JAMES CROIL.—Steam Navigation; Toronto, 1898.
A. J. MAGINNIS.—The Atlantic Ferry; London, 1900.
BASIL LUBBOCK.—The China Clippers; Glasgow, 1914.
The Cunard Line; London, 1902.
F. W. WALLACE.—Wooden Ships and Iron Men; Toronto, 1923.
BECKLES WILLSON.—Nova Scotia; New York, 1911.
Royal William; Trans. Royal Soc., Canada, 1892, 1893, 1894, 1895.

Pioneer Canadian Railways:

J. N. AND E. TROUT.—Railways of Canada; Toronto, 1871.
T. C. KEEFER.—Eighty Years Progress of British North America Toronto, 1863.
O. D. SKELTON.—The Railway Builders; Toronto, 1916.
SANDFORD FLEMING.—The Intercolonial; Montreal, 1876.

Early Mail Routes:

WILLIAM SMITH.—History of the Post Office in British North America; Cambridge, 1920.

MODERN TRANSPORTATION IN CANADA

BOARD OF RAILWAY COMMISSIONERS.—Annual Reports, Ottawa.
CANADIAN NATIONAL RAILWAYS.—Annual Reports, Ottawa.
CANADAIN PACIFIC RAILWAY.—Annual Reports.
DEPARTMENT OF RAILWAYS AND CANALS.—Annual Reports, Ottawa.
ALEXANDER BEGG.—History of the North-West; Toronto, 1894-5.
STATISTICAL ABSTRACT AND RECORD OF CANADA.—1886-88.
THE STATISTICAL YEAR BOOK OF CANADA.—1889-1904.
CANADA YEAR BOOK.—1904 to date.
DOMINION BUREAU OF STATISTICS.—Annual Canal Statistics.
CANADIAN ANNUAL REVIEW.—Toronto.
CONFEDERATION DEBATES.
SIR HENRY DRAYTON.—Addresses on Canada's Railway Problem.
EARL OF DURHAM.—Report on the Affairs of British North America; London, 1839.
SIR JOSEPH FLAVELLE.—Report on the National Railway Situation, 1921.
GRAND TRUNK RAILWAY ARBITRATION.—Report of Arbitrators; Ottawa, 1921.
SENATE AND HOUSE OF COMMONS.—Hansard Debates of; Ottawa.
HOUSE OF COMMONS' COMMITTEE ON TRANSPORTATION COSTS.—Proceedings, 1921.
ARTHUR HAWKES.—Life Story of a Canadian Railwayman, D. B. Hanna.
INNIS.—History of the Canadian Pacific Railway; Toronto, 1923.
MACGIBBON.—Railway Rates and the Canadian Railway Commission; Boston, 1917.
S. J. MCLEAN.—National Highways Overland, Vol. X, Canada and its Provinces; Toronto, 1915.
SIR JOSEPH POPE.—Memoirs of Right Honourable Sir John A. Macdonald; London, 1894.
W. T. R. PRESTON.—Life and Times of Lord Strathcona; London, 1914.
ROYAL COMMISSION TO INQUIRE INTO RAILWAYS AND TRANSPORTATION IN CANADA.—Report; Ottawa, 1917.
ROYAL COMMISSION ON LAKE GRAIN RATES.—Report; Ottawa, 1923.
O. D. SKELTON.—The Railway Builders; Toronto, 1916.
DOMINION BUREAU OF STATISTICS.—Annual Statistics of Steam Railways of Canada; Ottawa.
F. A. TALBOT.—The Making of a Great Canadian Railway; London, 1912.
SIR CHARLES TUPPER.—Recollections of Sixty Years in Canada; London, 1914.
WALTER VAUGHAN.—Life and Work of Sir William Van Horne; New York, 1920.
SIR JOHN WILLISON.—Sir Wilfred Laurier and the Liberal Party; Toronto, 1903.

FAUNAL AREAS OF CANADA

C. H. MERRIAM.—Laws of Temperature Control of the Geographic Distribution of Terrestrial Animals and Plants; National Geographic Magazine, 1894. Life Zones and Crop Zones of the United States; U.S. Geol. Surv., Bull. 10, 1898.

E. A. PREBLE.—North American Fauna; U.S. Biological Survey, Bull. 27, 1908.

E. T. SETON.—Life Histories of Northern Animals, 1909.

AMERICAN ORINITHOLOGISTS' UNION.—Check List of North American Birds, 3rd edition, 1910.

HOUGH.—Trees of North Eastern United States and Canada.

H. N. WHITFORD AND R. D. CRAIG.—Forests of British Columbia; Report of Commission of Conservation, Canada, 1918.

J. M. MACOUN AND M. O. MALTE.—Flora of Canada; Canada Year Book, 1915.

P. A. TAVERNER.—Faunas of Canada; Canada Year Book, 1915.

ATLAS OF CANADA.—Pages 17-20, 63-68; Dept. of the Interior, Canada, 1915.

D. R. DICE.—Life Zones and Mammalian Distribution; Jour. Mam., 1923.

A. B. KLUGH.—A Correction concerning the Life Zones of Canada; Biol. Bull. 41, p. 272, 1921.

METEOROLOGICAL SERVICE.—See Temperature and Precipitation Reports under "The Climate of Canada".

THE VEGETATION OF CANADA

C. J. BERKELEY.—Contributions to Canadian Biology, 4, p. 71, 1922.

F. K. BUTTERS.—Postelsia, pp. 133-212; St. Paul, Minn., 1906.

A. T. CAMERON AND I. MOUNCE.—Cont. Can. Biol., 4, pp. 41-70; Univ. of Toronto Press, 1922.

*B. R. MORTON AND R. H. LEWIS.—Native Trees of Canada; Dept. Interior, Canada, Bull. 61, 1917.

W. S. COOPER.—Ecology, 4, pp. 93-365, 1923.

W. C. COOPER.—The Plant World, 19, pp. 211-238, 1916.

J. DEARNESS.—Report Can. Arctic Expedition, 4C; Ottawa, 1923.

C. M. DERICK.—Trans. Royal Soc. Canada, Ser. III, Vol. XIII, Section IV, p. 67, 1920.

*C. K. DODGE.—Dept. Mines, Canada, Geol. Survey, Memoir 54, No. 2, 1914.

M. L. FERNALD.—Rhodora, Vol. 24, pp. 157-208, 1922; Vol. 23, pp. 89-200, 1921; Vol. 21, pp. 41-67, 1919.

B. E. FERNOW.—Forest Conditions in Nova Scotia; Comm. Conservation, Canada, 1912.

W. F. GANONG.—Bot. Gaz., Vol. 36, pp. 161-186; 280-302; 349-367; 429-455; 1903. Trans. Roy. Soc. Can., Ser. II, Vol. 3, pp. 131-163, 1897.

A. GRAY.—The Flora of North America; Scientific Papers, Vol. 2, p. 243, Boston and New York.

I. HENKEL.—Postelsia, pp. 275-304; St. Paul, Minn., 1906.

*J. W. HENSHAW.—Wild Flowers of the North American Mountains; New York, 1915.

H. Y. HIND.—Report of the Assiniboia and Saskatchewan Exploring Expedition; John Lovel, Toronto, 1858.
*T. HOLM.—Report Can. Arctic Expedition, 5B, Ottawa, 1922.
W. T. HORNADAY AND J. M. PHILLIPS.—Camp Fires in the Canadian Rockies; New York, 1907.
C. D. HOWE.—Distribution and Reproduction of the Forest in Relation to the Underlying Rocks and Soils; Forest Conditions of Nova Scotia, Rep. Comm. Con., Canada, 1912.
J. E. KIRKWOOD.—U.S. Dept. Interior, Bull. 53, 1918.
B. E. LIVINGSTON AND F. SHREVE.—The Distribution of Vegetation in the United States as related to Climatic Conditions; Carnegie Institute, Pub. 284, Washington, 1921.
F. E. LLOYD AND D. T. MACDOUGAL.—Bull. New York Botanical Gardens, Vol. I, pp. 419-429, 1900.
F. E. LLOYD.—Journal New York Botanical Gardens, Vol. 1, pp. 97-100, 1900. Plant World, Vol. 3, pp. 65-68; 85-87, 1900.
C. W. LOWE.—Report Can. Arctic Expedition, 4A, Ottawa.
J. M. MACOUN AND M. O. MALTE.—Flora of Canada; Canada Year Book, 1915.
JOHN MACOUN.—Autobiography; Ottawa, 1922.
*G. E. NICHOLS.—Trans. Connecticut Academy Arts and Sci., Vol. 22, pp. 249-467; Yale Univ. Press, 1918.
C. V. PIPER.—Cont. U.S. National Herbarium, Vol. 11, 1906.
G. B. RIGG.—Bull. Toronto Bot. Club, Vol. 40, pp. 237-242, 1913. The Plant World, Vol. 17, pp. 167-182, 1914.
REPORT OF THE JAMES BAY FOREST SURVEY.—Dept. Lands and Forests, Ontario, 1923.
*C. O. ROSENDAHL.—Postelsia, pp. 3-132; St. Paul, 1906.
H. ST. JOHN.—Proc. Boston Soc. Nat. Hist., Vol. 35, pp. 1-103, 1921.
SPECIAL REPORT, BRIT. EMP. FOR. CONF.—Forests and Forestry in Ontario; Ottawa, 1923.
W. A. SETCHELL.—Marine Flora of the Pacific Coast; Nature and Science on the Pacific Coast, pp. 177-184, 1915.
S. A. SKINNER.—Minnesota Botanical Studies, Sec. 3, Pt. 2, pp 145-165, 1903.
J. STANSFIELD.—Trans. Roy. Soc. Can., Series III, Vol. 13, 1920.
P. C. STANDLEY.—Cont. U.S. Nat. Herbarium, Vol. 22, Washington, 1921.
H. L. SHANTZ.—U.S. Dept. Agric., Bull. 201, 1911.
J. B. TYRRELL.—Geological Survey, Canada, Ann. Rep., Vol. IX, Pt. F., 1898.
J. W. TYRRELL.—Across the Sub-Arctics of Canada; Toronto, 1908.
FR. M. VICTORIN.—Revue Trimest. Can., Vol. 4, pp. 254-272, 1918.
L'Anse à Persi; Bull. Soc. Geo. Quebec; Quebec, 1914.
Revue Trimest. Can., Vol. 8, pp. 1-33, 1922.
Le Filicinees de Quebec; Suppl. Revue Trimest. Can., Vol. 9, 1923.
*La Flore du Temiscouata; Naturaliste Can., Quebec, 1916.
*M. B. WILLIAMS.—The Canadian Rockies; National Parks Commission, Ottawa, 1921.

*H. N. WHITFORD AND R. D. CRAIG.—Forests of British Columbia; Comm. Con. Can., Ottawa, 1918.

PLANT PATHOLOGY IN CANADA

H. P. BELL.—Fern Rusts of Abies; Bot. Gaz., March, 1924.

L. CAESAR.—Little Peach Disease, 1900.

B. T. DICKSON.—Diseases of the Potato; Scientific Agric., 2, pp. 55-57 et seq., 1921-22.

Studies concerning Mosaic Diseases; Macdonald College Techn. Bulletin, 1, 1922.

F. L. DRAYRON.—"Survey Reports" 1-4 of the Prevalence of Plant Diseases; Central Exp. Farm, 1920-23.

J. W. EASTHAM.—Diseases and Pests of Cultivated Plants; British Columbia Dept. Agric., Bull. 58, 1916.

J. H. FAULL.—Fomes officinalis (Vill.), a Timber-destroying Fungus; Trans. Royal Can. Inst., Vol. XI, 1917.

Forest Pathology; Reports of Minister of Lands and Forests, Ontario, 1918-1923.

Decay in Pulpwood; Pulp and Paper Mag. of Can., XXII, 1924.

W. P. FRASER.—Plant Disease Investigations in Western Canada; Agric. Gaz., Dom. Dept. Agric., Vol. 8, pp. 318-330, Ottawa, 1921.

C. W. FRITZ.—Cultural Criteria for the Distinction of Wood-destroying Fungi; Trans. Roy. Soc. Can., 1923.

H. T. GUSSOW.—A serious Potato Disease occurring in Newfoundland; Dom. Dept. Agric., Cent. Exp. Farm., Bull. 63, Ottawa, 1909.

Reports of Dominion Botanist; Dom. Dep. Agric., Cen. Exp. Farm, Ottawa, 1919-1923.

Potato Canker; Farmers' Circular No. 3, Cen. Exp. Farm, Ottawa, 1912.

Smut Diseases of Cultivated Plants; Div. Bot., Bull. 73, Cen. Exp. Farm, Ottawa, 1913.

Powdery Scab; Phytopath. III 1. 18, 1913.

Intern. Phytopath. Conf. Rome; Agric. Gazette Dom. Dep. Agric. I, p. 340, Ottawa, 1914.

Potato Inspection in Practice; Agric. Gaz., Dom. Dep. Agric. II, p. 415, Ottawa, 1915.

Plant Disease Legislation; Proc. Intern. Conf. Plant. Path. and Entomology, Wageningen, 1923.

The Aim and Organisation of the Plant Pathol. Serv.; Dom. Canada, Intern. Review, Vol. I, N.S. 1923, Intern. Inst. Agric. Rome.

F. C. HARRISON AND B. BARLOW.—Some Bacterial Diseases of Plants in Ontario, 1914.

J. E. HOWITT AND R. E. STONE.—Smuts and Rusts of Grain Crops; 1915, revised 1921.

J. E. HOWITT AND D. H. JONES.—The more important Fungus and Bacterial Diseases of Vegetables, 1917.

J. E. HOWITT AND L. CAESAR.—The more important Fruit Tree Diseases, 1917.

W. A. McCubbin.—Fruit Diseases of Southern Ontario; Cen. Exp. Farm, Bull. 24, 2nd Ser., Ottawa, 1915.
Tomato Diseases; Cen. Exp. Farm, Bull. 35, 2nd Ser., Ottawa, 1918.
P. A. Murphy.—Apple Dusting in Nova Scotia; 23rd Ann. Rep., N.S. Fruit Growers' Association, 1917.
Investigation of Potato Diseases; Cen. Exp. Farm, Bull. 44, 2nd Ser., Ottawa, 1921.
M. A. Newton.—A Preliminary Report on the Occurrence of Biologic Forms of Wheat Stem Rust in Canada; Scient. Agric., Vol. 1, p. 213, 1921.
Studies in Wheat Stem Rust; Trans. Roy. Socy. Can., Ser. III, Sect. V, 1922.
W. H. Rankin and J. F. Hockey.—Mosaic and Leaf Curl of the Cultivated Red Raspberry; Dom. Exp. Farm, Div. Bot., Circular 1, New Ser., Ottawa, 1922.
J. H. White.—On the Biology of Fomes Applanatus; Trans. Roy. Can. Inst., Vol. XII, Toronto, 1919.

THE FORESTS AND FOREST INDUSTRIES OF CANADA

Commission of Conservation, Canada.—The Forests of British Columbia; Ottawa, 1918.
Forest Conditions of Nova Scotia; Ottawa, 1912.
Forest Protection in Canada, Ottawa, 1913, 1914.
Dominion Forestry Branch.—Annual Reports, Ottawa.
Forestry Branch, Ontario.—Annual Reports, Toronto.
Forestry Branch, British Columbia.—Annual Reports, Victoria.
Forestry Branch, Quebec.—Annual Reports, Quebec.
Forestry Branch, New Brunswick.—Annual Reports, Fredericton.
Defabaugh.—The History of the Lumber Industry of America; American Lumberman, Vol. I, Chicago.

THE DEVELOPMENT OF THE PULP AND PAPER INDUSTRY IN CANADA

Department of the Interior.—Reports of Forestry Branch, Ottawa.
Reports, Dominion Bureau of Statistics (since 1917), Ottawa.
Reports, Commission of Conservation, Ottawa.
Provincial Departments.—Various Reports, Provincial Departments of Lands and Forests; Various Reports, Provincial Foresters.
The Pulp and Paper Magazine.—Journal, Gardenvale, Quebec.

THE FISHERIES OF CANADA

J. M. Lemoine.—Les Pécheries du Canada; Quebec, 1863.
L. Joncas.—Fisheries of Canada (International Fish Exhibition); Clowes & Sons, London, 1883.
R. Ramsay Wright.—Great Lakes Fish and Fisheries; Ontario Fish and Game Commission, Toronto, 1892.

C. W. NASH.—Check List of Ontario Fishes (with figures); Department of Education, Toronto, 1908.
E. E. PRINCE.—Fisheries of Manitoba; B.A.A.S. Handbook, Winnipeg, 1909.
Canada's Fisheries; Dominions Royal Commission, H. M. Stationery Office, London, 1920.
Fisheries of Canada; London Times Book of Canada, 1921.
Fisheries of Maritime Provinces; Industrial Canada, Toronto, 1922.
FISHERIES DEPARTMENT.—Reports, Ottawa.
BIOLOGICAL BOARD.—Reports (especially Contributions to Canadian Biology), Ottawa.

THE FUR TRADE IN CANADA

VERNON BAILEY.—Beaver Habits and Beaver Control and Possibilities in Beaver Farming; Dept. Agric., Washington, 1922.
H. H. BANCROFT.—History of the North West Coast.
A. L. BELDEN.—The Fur Trade of America; Peltries Pub. Co., New York.
L. J. BURPEE.—Pathfinders of the Great Plains; Chronicles of Canada, Vol. 19.
GEORGE BRYCE.—Makers of Canada, Vol. 8; Morang & Co., 1910.
E. J. CHAMBERS.—The Unexploited West; Natural Resources Intelligence Service, Dept. Interior, Ottawa.
JAMES COOK.—A Voyage to the Pacific Coast; 1785.
W. T. CURRAN AND H. A. CALKINS.—In Canada's Wonderful Northland; G. P. Putnam's Sons, New York, 1917.
DEPARTMENT OF THE INTERIOR.—Canada, Natural Resources and Commerce; Natural Resources Intelligence Service, Ottawa.
Reports of Canadian National Parks Branch.
Game Preservation in the Rocky Mountain Forest Reserve; Forestry Branch.
North West Territories Game Act; North West Territories Branch.
DEPARTMENT OF MINES.—Geological Survey, Summary and Annual Reports.
DEPARTMENT OF TRADE AND COMMERCE.—Reports on the Fur Farms of Canada; Fur Protection in Canada; Dominion Bureau of Statistics.
N. E. DIONNE.—Makers of Canada, Vol. I; Morang & Co., 1910.
FUR AUCTION REPORTS.—London, Montreal, New York, St. Louis.
FUR TRADE REVIEW.—New York.
D. V. HARMON.—A Journal of Voyage and Travel in the Interior of North America; Trail Makers of Canada; Courier Press, Toronto, 1911.
PAUL HAWORTH.—At the Headwaters of the Peace.
C. GORDON HEWITT.—The Conservation of Wild Life in Canada; Charles Scribner's Sons, New York, 1921.
WASHINGTON IRVING.—Astoria; Co-operative Pub. Soc'y., New York.
J. WALTER JONES.—Fur Farming in Canada; Comm. of Con., Canada.

AGNES LAUT.—The Fur Trade of America; MacMillan & Co., New York.

ALEXANDER MACKENZIE.—Voyages from Montreal through the Continent of North America to the Frozen and Pacific Oceans, in the Years 1789 and 1793; London, 1801.

MARCUS PETERSON.—Fur Traders and Fur-Bearing Animals; Fur Traders' Lexicon; Peterson and Chandless, New York.

HENRY POLAND.—Fur-Bearing Animals in Nature and Commerce; Statistics.

EDWARD A. PREBLE.—North American Fauna; Biological Survey, Washington.

PROVINCIAL REPORTS AND GAME ACTS.

CHARLES B. REED.—The First Great Canadian; A. G. McClurg & Co., Chicago, 1910.

SIR WILLIAM SCHOOLING.—The Hudson's Bay Company, 1670-1920; Hudson's Bay Company, London.

E. T. SETON.—The Arctic Prairie Constable, London, 1912.
Life Histories of Northern Animals; Charles Scribner's Sons, New York.

A. SHORTT AND A. DOUGHTY.—Canada and its Provinces; Glasgow Brook & Co., Toronto, 1914.

V. STEFANSSON.—My Life among the Eskimo.

BECKLES WILLSON.—The Great Company; The Copp Clark Co., Toronto.

JUSTIN WINSOR.—The Mississippi Basin; Houghton Mifflin Co., 1898.

WHEAT IN THE WEST

THE SELKIRK PAPERS.—In Archives Building, Ottawa.

A. ROSS.—The Red River Settlement; London, 1856.

REPORT FROM THE SELECT COMMITTEE ON THE HUDSON'S BAY COMPANY.—1857.

JOHN MACOUN.—Manitoba and the Great North-west; Guelph, 1882.

WINNIPEG GRAIN EXCHANGE.—Annual Reports.

CHESTER MARTIN.—Lord Selkirk's Work in Canada; Oxford, 1916.

SUPPLEMENT TO THE CEREAL MAPS OF MANITOBA, SASKATCHEWAN, AND ALBERTA.—Ottawa, 1917.

MONTHLY BULLETIN OF AGRICULTURAL STATISTICS.—Ottawa.

V. C. FINCH AND O. E. BAKER.—Geography of the World's Agriculture; Washington, 1917.

ROBERT MAGILL.—Grain Inspection in Canada; Department of Trade and Commerce, Ottawa.

C. B. PIPER.—Principles of the Grain Trade; The Empire Elevator Company, Limited, Winnipeg, 2nd edition, 1917.

A. H. R. BULLER.—Essays on Wheat, including the Discovery and Introduction of Marquis Wheat, the Early History of Wheat-growing in Manitoba, Wheat in Western Canada, The Origin of Red Bobs and Kitchener, and the Wild Wheat of Palestine; The MacMillan Company, New York, 1919.

GLACIAL FEATURES OF CANADA

GEOLOGICAL SURVEY, CANADA.—Annual Reports; Memoirs, Ottawa.

BUREAU OF MINES, ONTARIO.—Annual Reports, Toronto.
ONTARIO DEPARTMENT OF MINES.—Annual Reports, Toronto.
TWELFTH INTERNATIONAL GEOLOGICAL CONGRESS.—Guide Book, No. 6, Toronto, 1913.
GLACIAL AND POST-GLACIAL LAKES IN ONTARIO.—University of Toronto Studies, Biological Series, No. 21, Toronto, 1922.

THE DINOSAURS OF ALBERTA

LAWRENCE M. LAMBE.—Geological Survey, Canada, Cont. Can. Pal., Vol. III, Pt. II, 1891.
Geol. Surv. Canada, Memoir 100; Ottawa, 1917.
Geol. Surv. Canada, Memoir 120; Ottawa, 1920.
Ottawa Naturalist, Vol. XXXI, Oct. 1917; Feb., 1918.
Ottawa Naturalist, Vol. XXVII, Dec., 1913; Jan., 1914.: Feb., 1914
Trans. Royal Socy. Can., Ser. III, Vol. XIII, Sect. IV, 1920.
BARNUM BROWN.—Bull. Am. Mus. Nat. Hist., Vol. XXXII, Articles XIX, XX, XL, 1913;
Vol. XXIII, Articles XXXIII, XXXIV, XXXV, XXXVI, 1914;
Vol. XXXV, Articles XXXVII, XXXVIII, 1916;
Vol. XXXVII, Article X, 1917; Vol. XLVI, Article VI, 1922.
W. D. MATTHEW AND BARNUM BROWN.—American Museum Novitates, No. 89, New York, 1923.
CHARLES W. GILMORE.—Canadian Naturalist, Vol. XXXVII, No. 3, 1923.
Geol. Surv. Canada, Bulletin 38, 1924.
Univ. of Alberta, Dept. Geology, Bulletin No. 1, 1924, Edmonton.
W. A. PARKS.—University of Toronto Studies, Geol. Series, Nos. 11, 13, 15, Toronto.
Trans. Royal Society Can., Ser. III, Vol. XIII, Section IV, 1920; Vol. XV, Section IV, 1921.
C. M. STERNBERG.—Trans. Royal Socy. Can., Ser. III, Vol. XV, Section IV, 1921.

THE CHEMICAL AND METALLURGICAL INDUSTRIES OF CANADA

BUREAU OF STATISTICS.—Reports, Ottawa.
REPORT ON CHEMICAL INDUSTRIES OF CANADA.—Ottawa, 1918, 1920.
CHEMICALS AND ALLIED PRODUCTS.—Ottawa, 1920.
DEPARTMENT OF MINES.—Reports of Mines Branch; Reports of Geological Survey.
ONTARIO DEPARTMENT OF MINES.—Reports, Toronto.
MINISTER OF MINES, BRITISH COLUMBIA.—Annual Reports, Victoria.
DEPARTMENT OF COLONISATION, MINES, AND FISHERIES, QUEBEC.—Annual Reports on Mining Operations, Quebec.
DEPARTMENT OF MINES, NOVA SCOTIA.—Annual Reports, Halifax.
CANADIAN CHEMISTRY AND METALLURGY.—Journal, Toronto.
CANADIAN MINING JOURNAL.—Journal, Gardenvale, Quebec.
CANADIAN INSTITUTE OF MINING AND METALLURGY.—Bulletins and Transactions, Montreal.

INDEX

NOTE.—All references are to Canada unless otherwise mentioned.

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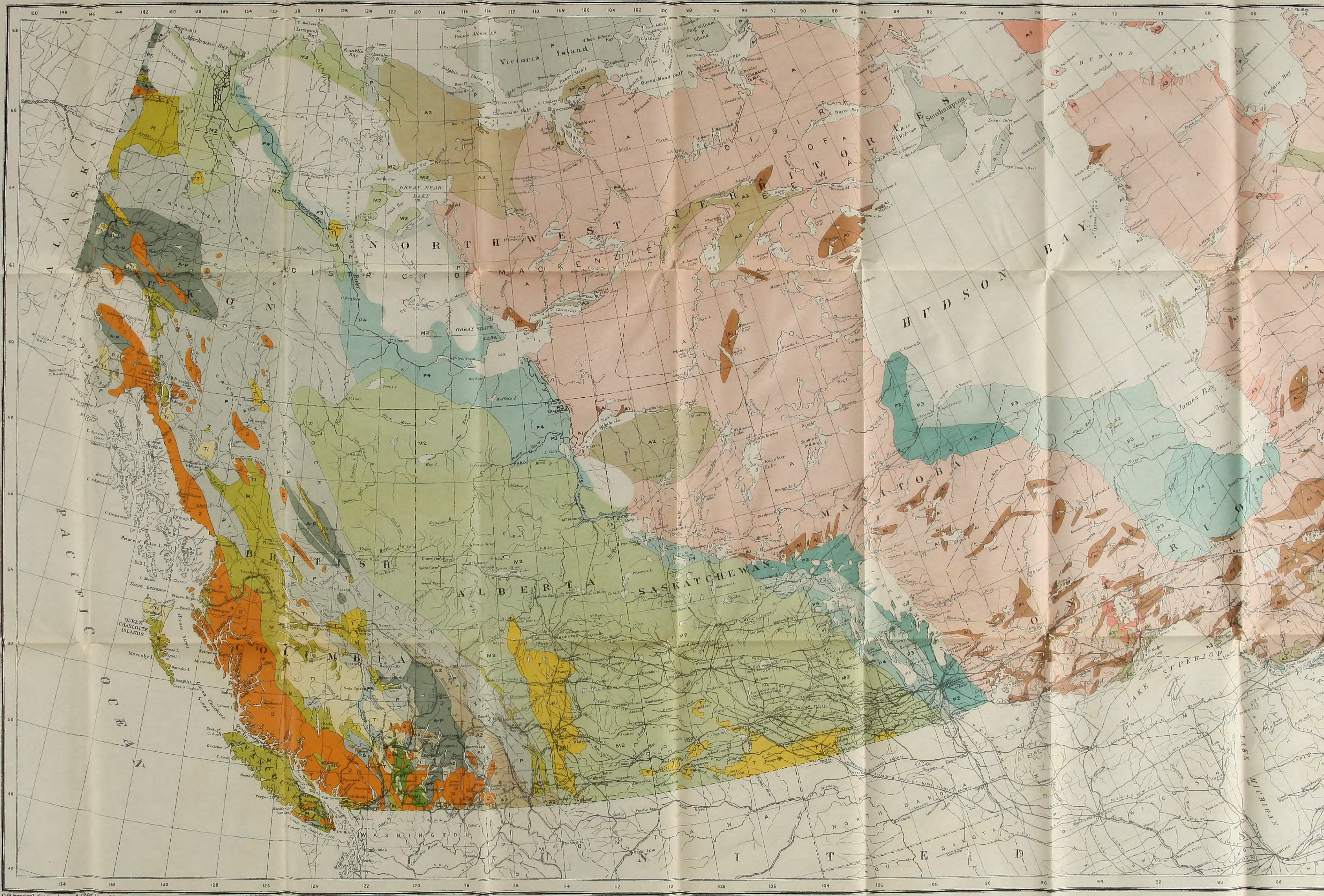

C.O. Senécal, Geographer and Chief Draughtsman.

LEGEND

TERTIARY

T1 Volcanic rocks

T Sedimentary rocks

MESOZOIC

M2 Cretaceous

M1 Triassic (includes volcanics and intrusives)

M Mesozoic, unclassified (chiefly Jurassic and Cretaceous except along Pacific coast where largely Triassic with some Palæozoic; includes volcanics)

PALÆOZOIC

P5 Carboniferous (in Cordilleran region includes volcanics and intrusives)

P4 Devonian

P3 Silurian

P2 Ordovician

P1 Cambrian and Lower Ordovician

P Unclassified (chiefly Palæozoic; in west includes some Mesozoic)

A-P Unclassified (Palæozoic and Precambrian, chiefly; includes volcanics and intrusives)

PRECAMBRIAN

A2 Late Precambrian (includes Beltian, Huronian, and other strata supposedly not older than Huronian; in Cordilleran region includes some undivided Palæozoic)

A1 Early Precambrian (includes Timiskaming, Keewatin, and other strata supposedly older than Huronian)

A3 Precambrian, unclassified (sediments, volcanics and plutonics)

A Precambrian, unclassified (chiefly granite and granite-gneiss)

Igneous

2 Granite, diorite

1 Anorthosite, gabbro, diabase

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